Sum of Squares Total, Sum of Squares Regression and Sum of Squares Error

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You may be wondering what all of those **sums of squares** are all about. Maybe that's what got you here in the first place. Well, they are the determinants of a good linear **regression** (https://365datascience.com/linear-regression/). This tutorial is based on the ANOVA framework (https://www.xlstat.com/en/solutions/features/anova-analysis-of-variance) you may have heard before.

Before reading it, though, make sure you are not mistaking **regression** for **correlation** (https://365datascience.com/correlation-regression/). If you've got this checked, we can get straight into the action.

A quick side-note: Want to learn more about linear regression? Check out our explainer videos The Linear Regression Model. Geometrical Representation

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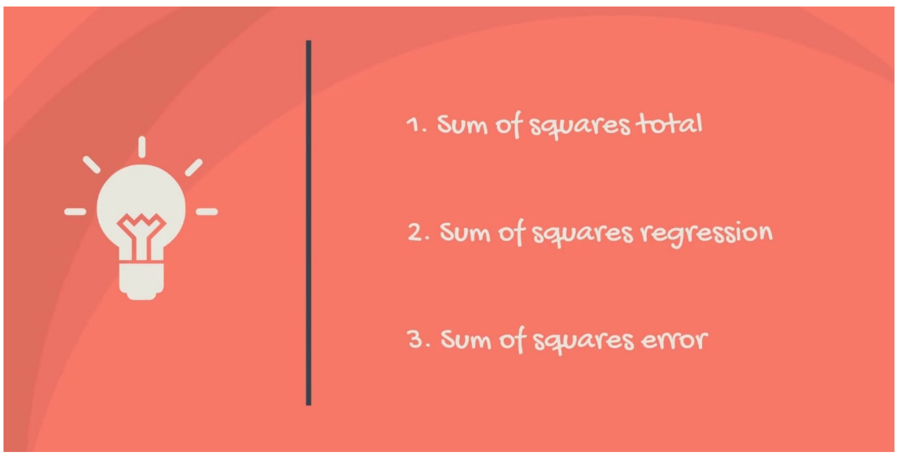
SST, SSR, SSE: Definition and Formulas

There are three terms we must define. The **sum of squares total**, the **sum of squares regression**, and the **sum of squares error**.



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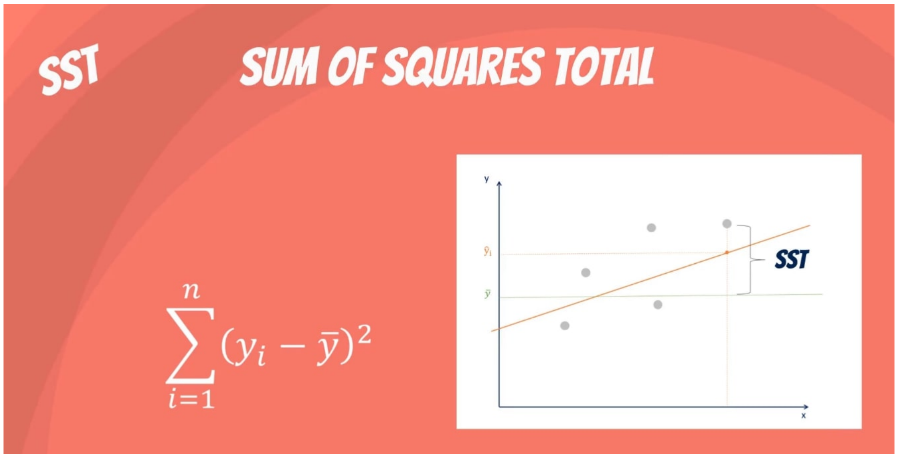
What is the SST?

The **sum of squares total**, denoted **SST**, is the squared differences between the observed *dependent variable* and its **mean**. You can think of this as the dispersion of the observed variables around the **mean** (https://365datascience.com/measures-central-tendency/) – much like the **variance** in descriptive statistics (https://365datascience.com/coefficient-variation-variance-standard-deviation/).



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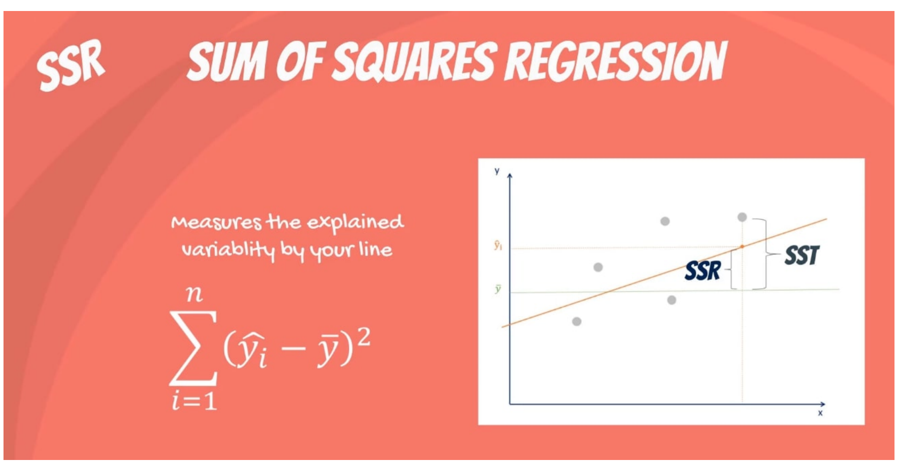
It is a measure of the total variability of the dataset.

Side note: There is another notation for the **SST**. It is **TSS** or **total sum of squares**.

What is the SSR?

The second term is the **sum of squares due to regression**, or **SSR**. It is the sum of the differences between the *predicted* value and the **mean** of the *dependent variable*. Think of it as a measure that describes how well our line fits the data (https://365datascience.com/numerical-categorical-data/).



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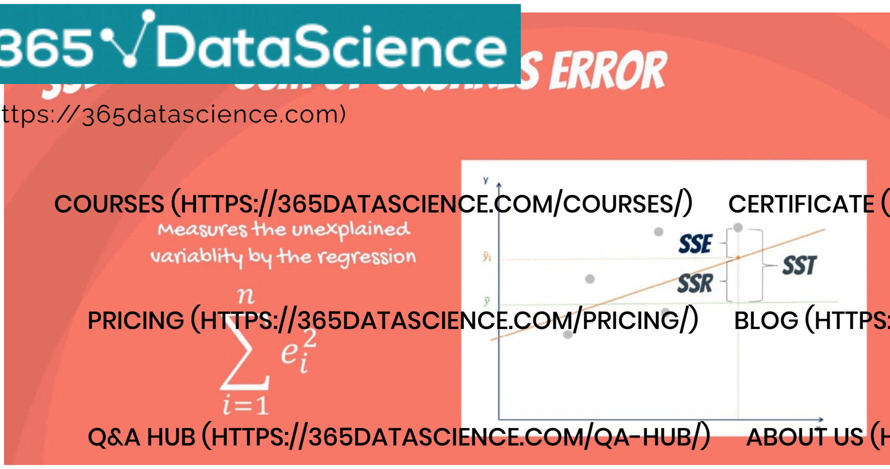
If this value of **SSR** is equal to the **sum of squares total**, it means our **regression model** captures all the observed variability and is perfect. Once again, we have to mention that another common notation is **ESS** or **explained sum of squares**.

What is the SSE?

The last term is the **sum of squares error**, or **SSE**. The error is the difference between the *observed* value and the *predicted* value.



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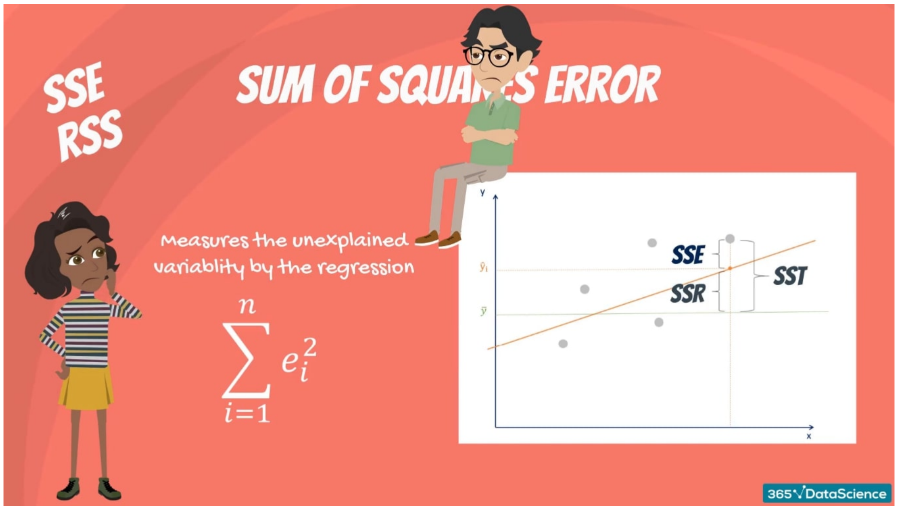
We usually want to minimize the error (https://365datascience.com/false-positive-vs-false-negative/). The smaller the error, the better the estimation power of the **regression**. Finally, I should add that it is also known as **RSS** or **residual sum of squares**. Residual as in: remaining or unexplained.

The Confusion between the Different Abbreviations

It becomes really confusing because some people denote it as **SSR**. This makes it unclear whether we are talking about the **sum of squares due to regression** or **sum of squared**

residuals.



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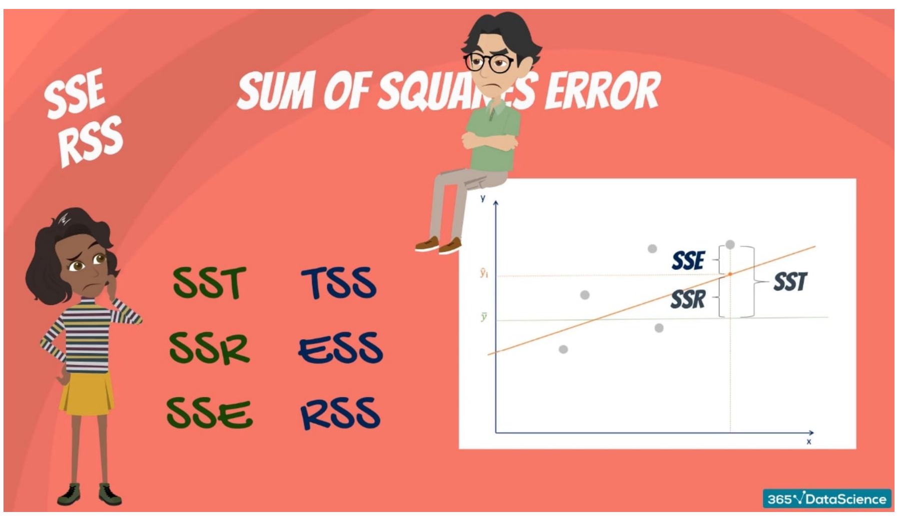
In any case, neither of these are universally adopted, so the confusion remains and we'll have to live with it.

Simply remember that the two notations are **SST**, **SSR**, **SSE**, or **TSS**, **ESS**, **RSS**.



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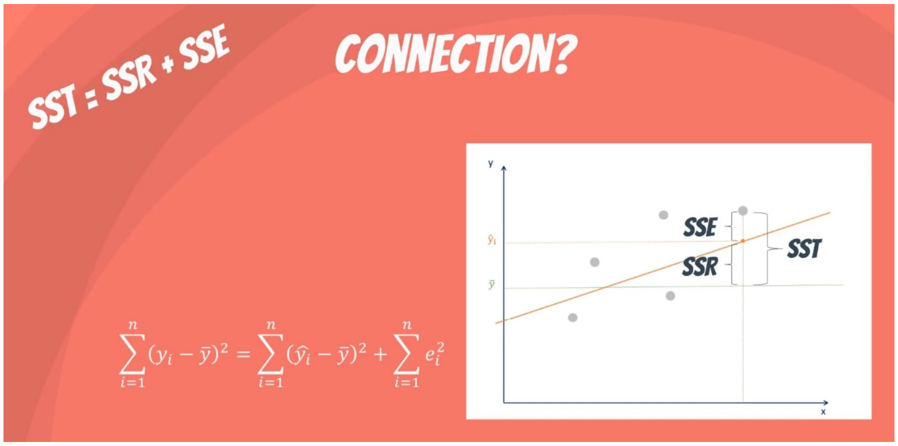
There's a conflict regarding the abbreviations, but not about the concept and its application. So, let's focus on that.

How Are They Related?

Mathematically, **SST** = **SSR** + **SSE**.



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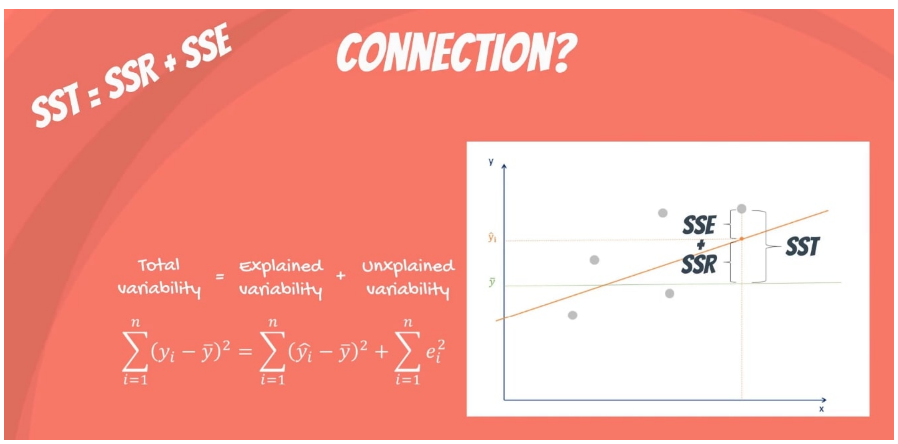
The rationale is the following: the total variability of the data set is equal to the variability explained by the **regression line** plus the unexplained variability, known as error.



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Given a constant total variability, a lower error will cause a better **regression**. Conversely, a higher error will cause a less powerful **regression**. And that's what you must remember, no matter the notation.

Next Step: The R-squared

Well, if you are not sure why we need all those **sums of squares**, we have just the right tool for you. The **R-squared.** Care to learn more? Just dive into the linked tutorial where you will understand how it measures the explanatory power of a linear regression!

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Next Tutorial: Measuring Variability with the R-squared (https://365datascience.com/r-squared/)

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