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Measurement Of Uncertainty: Standard Deviation

Many experiments require measurement of uncertainty. Standard deviation is the best way to accomplish this. Standard deviation tells us about how the data is distributed about the mean value.

Examples

For example, the data points 50, 51, 52, 55, 56, 57, 59 and 60 have a mean at 55 (Blue).

Another data set of 12, 32, 43, 48, 64, 71, 83 and 87. This set too has a mean of 55 (Pink).
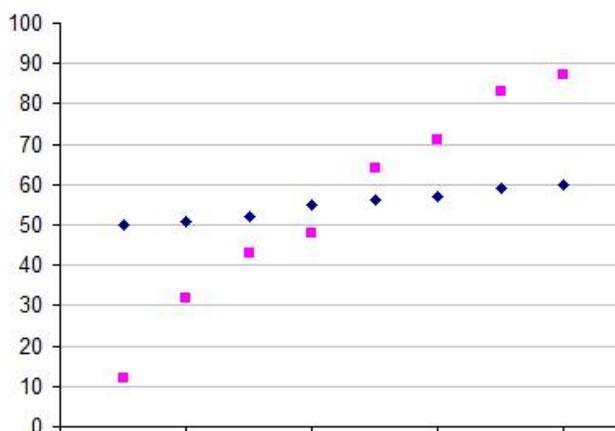
However, it can clearly be seen that the properties of these two sets are different. The first set is much more closely packed than the second one. Through standard deviation, we can measure this distribution of data about the mean.

The above example should make it clear that if the data points are values of the same parameter in various experiments, then the first data set is a good fit, but the second one is too uncertain. Therefore in measurement of uncertainty, standard deviation is important [1] - the lesser the standard deviation, the lesser this uncertainty and thus more the confidence [2] in the experiment, and thus higher the reliability of the experiment.

One Standard Deviation

In a normal distribution [3], values falling within 68.2% of the mean fall within one standard deviation. This means if the mean energy consumption of various houses in a colony is 200 units with a standard deviation of 20 units, it means that 68.2% of the households consume energy between 180 to 220 units. This is assuming that the data of energy consumption is normally distributed.

If a researcher considers three standard deviations to either side of the mean, this covers 99% of the data. Thus in the previous example, 99% of the households have their energy consumption between 140 to 260 units. In most cases, this is considered as the whole data set [4], especially when the data can extend to infinity.

Usage

The measurement of uncertainty through standard deviation is used in many experiments of social sciences and finances. For example, the more risky and volatile ventures have a higher standard deviation. Also, a very high standard deviation of the results for the same survey [5], for example, should make one rethink about the sample size and the survey as a whole.

In physical experiments, it is important to have a measurement of uncertainty. Standard deviation provides a way to check the results. Very large values of standard deviation can mean the experiment is faulty - either there is too much noise from outside or there could be a fault in the measuring instrument.

Links
[1] http://www.robertniles.com/stats/stdev.shtml
[2] https://explorable.com/statistics-confidence-interval
[3] https://explorable.com/normal-probability-distribution
[4] https://explorable.com/statistical-data-sets
[5] https://explorable.com/survey-research-design