Some notes on z- scores and t- scores

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Abstract:

A symmetrical distribution of scores , where there is an equal number of scores above and below the midpoint, is called the normal curve. A measure of the variability of a distribution of scores is obtained by standard deviation. In order to standardize test scores, a researcher needs to have an idea about the standard deviation of the distribution of the raw scores. When raw scores are converted to standard scores, we say that the scores are "standardized." This process is useful as the individual raw scores are transformed into a standard form. Both z score and t- score are used in hypothesis testing. Generally, when standard deviation of the population is known and the sample size is above 30, we use z score, else, we use t-score. Basically, when we convert individual scores to standard form, we get z scores which are used to find out by from many standard deviations from the mean the result lies. Such scores are used extensively in educational and psychological fields as these are consistent across tests , making it easy for comparison of scores. This paper deals with some notes on z-scores and t-scores.

Keywords: Standardized scores, z-scores, t-scores, education, recruitment

Introduction:

All methods and tools used for collecting, organizing, analysing and interpreting observationa can be called as "Statistics". One of the most important areas in statistics is conclusions from the data. Standardisation of scores help in ordering so that the scores can be presented on a scale which is easily understandable. Also, when used in educational field, it can be used to take into account the differing ages or factors of pupils. Only through standardisation can we meaningfully compare scores.

Job recruitments , for example can be of various types. It can be a personal interview or a combination of different tools of assessments. When there is more than one assessment, it becomes important to standardize these as each test is on a different scale. An immediate connection can be achieved using a z-score or t-score which express scores in relation to the other candidates' scores rather than the raw scores. In the case of z-score, the average is always zero and range from -3 to +3. Whereas t-scores have an average of 50 and range from 20 and 80. Though both are acceptable, sometimes, people prefer t-scores as there are no negative numbers and also as the range is larger.

Consider another example, of two students A and B in different sections. A got a score of 70 whereas the mean score of his/ her section was 60. B got 80 whereas his section's mean score was 70. This information tells that both A and B were 10 marks above average of their respective sections but does not speak about spread of the distribution, in other words, how the person scored with respect to others in the class. The scores are converted into normalized or z scores so that a standard scale is obtained to help in comparison. The process of converting or transforming scores on a variable to Z-scores is called standardization.

Note: Z-Scores are a transformation of raw scores into a standard form, where the transformation is based on knowledge about the population's mean and standard deviation. T-Scores are a transformation of raw scores into a standard form, where the transformation is made when there is no knowledge of the population's mean and standard deviation and are computed by using the sample's mean and standard deviation, which is the best estimate of the population's mean and standard deviation

Converting raw scores into standard normalized scores (Z- scores):

When data is available on different kinds of assessment tests, we cannot compare those scores directly, unless, of course, the scales of these two tests are same. This problem can be overcome using normal curve. We convert the raw scores to standard normalized scores by using the relation $z=\frac{x-\mu}{\sigma}$. This clearly indicates how many standard deviation units a raw score is above or below the mean, thus providing a standard scale for comparison.

Note 1: Converting x scores to z scores will not change the shape of the distribution. It is to be noted, however, that the distribution of z scores is normal if and only if the distribution of x is normal.

Note 2: If z values can be negative or in decimals, they are converted into t values by multiplying with some constants and added to some other constants. E.g.: T= 10z+ 40

Case studies:

Case study 1: A student obtains 90 marks in math and 60 in English. If the mean and standard deviation of scores are 70 and 20 for math and 55 and 10 for English, find the subject in which he scored better.

A layman would probably conclude that math is better as he scored 30 more, on an average in that subject. But this will be erroneous as standard deviation is also in the picture. The right way would be to convert these scores into z scores as follows:

Z score in math = $\frac{90-70}{20}$ = 1

Z score in English = $\frac{50-55}{10}$ = 1.5

Thus, he has done better in English than in math, as is obvious from the z-scores.

Note: In educational and psychological testing, normal distribution used to determine the relative difficulty of test questions. Let a paper have 3 sub divisions, A, B and C. Let the number of students who answered section A correctly be 25% i.e. 75% are not able to correctly answer it. Similarly, let 10 % and 20% be the number of people who have answered section B and C correctly, thus, 90% and 80% have found section B and C tough. We assume that the ability measured by these three items is same and it is normally distributed.

Case Study 2: The score for each student in a class is used to calculate the mean of marks which is equal to 50 and SD of 10. What can we say about a student?

(i) with a score of 50?

The z-score is (50-50)/10 = 0.

Interpretation: student score is 0 distance (in units of standard deviations) from the mean, so the student has scored average.

(ii) with a score of 60?

The z-score is (60-50)/10 = 1.

Interpretation: student has scored above average - a distance of 1 standard deviation above the mean.

(iii) with a score of 69.6?

The z-score is (69.6-50)/10 = 1.96.

Interpretation: student has scored above average - a distance of 1.96 above the average score.

A note to researchers: the normal distribution is very important in all fields as well as in the social sciences but it is essential to recognize that not all human attributes or behavioral events are normally distributed. Many phenomena display extremely skewed distributions with long upper tails. Examples include the distributions of annual income across households in the country, the output of journal articles by researchers doing Phd, the number of violent acts committed by college students etc.

What is to be done then? Use an appropriate data transformation, for instance, a lognormal distribution becomes normal after a logarithmic transformation. But still, many important variables cannot be normalized in this way. Then, the researchers may use statistics based on the non-normal distribution or else the various nonparametric or distribution-free methods. Normal distributions occur when multiple causal processes are additive, whereas the non normal ones occur when those processes are multiplicative.

CONCLUSIONS:

Standardisation of scores is an extensively used procedure in the field of research and planning as they help in comparison of various test scores. Standardizing scores before combining them is helps a researcher to get better and comparable results.

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