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Stevens' Four Scales of Measurement: The Addition of a New Scale

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Stevens' classification of four scales of measurement is widely used by statisticians, data analysts, and the everyday data mechanics. However, it is by no means universally accepted. [1, 2]

I for one need an addition to Stevens' classification:

Nominal, **Categorical**, Ordinal, Interval, and Ratio

The purpose of this article is to briefly review Stevens' scales of measurement, and solicit your comments on my proposed categorical scale. If you would like my discussion on the addition of the categorical scale, please email me at br@dmstat1.com.

The following discussion of Stevens' scales of measurement is taken from Ratner (*Statistical and Machine-Learning Data Mining: Techniques for Better Predictive Modeling and Analysis of Big Data*: 57–58.)

Nominal data are classification *labels*, for example, color (red, white, and blue); there is no ordering of the data values. Clearly, arithmetic operations cannot be performed on nominal data. That is, one cannot add red + blue (= ?).

Ordinal data are *ordered* numeric labels in that higher/lower numbers represent higher/lower values on the scale. The intervals between the numbers are not necessarily equal.

For example, consider the variables CLASS and AGE as per traveling on a cruise liner. I recode the CLASS labels (first, second, third, and crew) into the ordinal variable CLASS_, implying some measure of income. Also, I recode the AGE labels (adult and child) into the ordinal variable AGE_, implying years old.

1. if CLASS = first then CLASS_ = 4
2. if CLASS = second then CLASS_= 3
3. if CLASS = third then CLASS_= 2
4. if CLASS = crew then CLASS_= 1
5. if AGE = adult then AGE_= 2
6. if AGE = child then AGE_= 1

One cannot assume the difference in income between CLASS_=4 and CLASS_=3 equals the difference in income between CLASS_=3 and CLASS_=2.

Arithmetic operations (e.g., subtraction) cannot be performed. With CLASS_ numeric labels, one cannot conclude 4 - 3 = 3 - 2. Only the logical operators "less than" and "greater than" can be performed.

Another feature of an ordinal scale is that there is no “true” zero. This is so because the CLASS_ scale, which goes from 4 through 1, could have been recorded to go from 3 through 0.

Interval data are measured along a scale in which each position is equidistant from one another. This allows for the distance between two pairs to be equivalent in some way.

Consider the HAPPINESS scale of 10 (= most happy) through 1 (= very sad). Four persons rate themselves on HAPPINESS:

- Persons A and B state 10 and 8, respectively.
- Persons C and D state 5 and 3, respectively.

One can conclude that person-pair A and B (with happiness difference of 2) represents the same difference in happiness as that of person-pair C and D (with happiness difference of 2).

Interval scales *do not* have a true zero point; therefore, it is not possible to make statements about how many times happier one score is than another.

Interval data cannot be multiplied or divided. The common example of interval data is the Fahrenheit scale for temperature. Equal differences on this scale represent equal differences in temperature, but a temperature of 30° is not twice as warm as a temperature of 15°. That is, 30° - 20° = 20° - 10°, but 20°/10° is not equal to 2. That is, 20° is not twice as hot as 10°.

Ratio data are like interval data except they *have* true zero points. The common example is the Kelvin scale of temperature. This scale has an absolute zero. Thus, a temperature of 300 K is twice as high as a temperature of 150 K.

What is a true zero? Some scales of measurement have a true or natural zero.
For example, WEIGHT has a natural 0 at no weight. Thus, it makes sense to say that my beagle Matzi weighing 26 pounds is twice as heavy as my dachshund Dappy weighing 13 pounds. WEIGHT is on a ratio scale.

Reference

1. Stevens, S.S., On the theory of scales of measurement, *American Association for the Advancement of Science*, 103(2684), 677–680, 1946.
2. Velleman, Paul F.; Wilkinson, Leland (1993). Nominal, Ordinal, Interval, and Ratio Typologies Are Misleading. *The American Statistician* (American Statistical Association) 47 (1): 65–72.