

Levels of Measurement: what you can and can't do arithmetically by Heather Wharrad

Learning objective: To understand the arithmetic and statistical operations that can be carried out on the four levels of measurement

www.ucel.ac.uk/rlos/levels_arithmetic/

1 Introduction

Knowing the level of measurement you are dealing with is important because it helps you to decide what arithmetic and statistical operations you can carry out on the values that have been assigned.

A spreadsheet package like Excel will allow you to perform all sorts of complex calculations on tables of data – but the results you get may be meaningless if you don't understand which operations are permissible for each level. For instance, you can assign 1 to males and 2 to females, but if you add up all the values, the total will not help you!

2 Nominal

At the nominal level the numbers assigned to an attribute are simply representations so they can't be added or subtracted or subjected to any arithmetic process. But the numbers in each category can be counted. In the spreadsheet shown, a team of footballers was asked whether they were left or right footed. Left footed players are entered onto the spreadsheet as 1 and right footed players as 2. How many left footed and right footed players are there in this team? Yes that's right there are 2 left and 9 right footed. So you can see it's perfectly valid to count the numbers (or frequency) in each category, but to average the 1s and 2s would be nonsense. Similarly adding up all the numbers on footballers shirts is possible - it comes to 66 - but this figure doesn't mean anything!

3 Ordinal

Arithmetic operations that can be performed on values assigned to ordinal scales are also limited. As well as counting the numbers in each category on the scale it is possible to indicate relative size using equals =, greater than > or less than < symbols. Any operation involving addition and subtraction is not allowed - for example calculating the mean. Calculating the median and mode as measures of central tendency is OK as these only involve counting the numbers in each category on the scale.

4 Interval

Because the size between intervals is equal within any one scale, you can add and subtract these values. Multiplication and division is not permitted because there is no absolute zero, and, for instance, a temperature of 40 deg C is not twice as hot as a temperature of 20 deg C. Comparisons across different scales (for example centigrade to Fahrenheit,) should be handled with care, because they're not starting from the same zero point and although the intervals within a scale are equal, the size of the intervals on different scales will vary.

5 Ratio

Multiplication and division should only be carried out on ratio measurements. Naturally, addition and subtraction are also permitted. So an increasingly complex level of calculation can be performed for each level of measurement. An inappropriate arithmetic operation will still yield a result but it will be meaningless.

6 Activity

Here's a spreadsheet listing a number of people. Females are assigned 1 and males 2. Their height s, weight s, temperatures and shoe sizes are also recorded. The shoe sizes are converted to mm using a look up table. Mark which total boxes for each column should be permitted..

shoe size	euro	mm	name	sex	height	weight	temp C	shoe size	shoe size (mm)
4	36.5	245	Anne	1	1.46	56	36.86	4	245
5	38	252	Tim	2	1.87	80	37.02	10	298
6	39	260	Mathew	1	1.76	86	37.07	8	278
7	40.5	270	Sheila	2	1.34	58	36.78	5	252
8	41.75	278	Soraya	2	1.70	72	36.64	6	260
9	43	286	Ben	1	1.77	94	36.97	9	286
10	44.5	298	Bob	1	1.89	84	37.01	11	305
11	45.5	305	Sue	2	1.82	65	36.83	8	278
			Total?						
			Mean?						
			Median?						

7 Answers

name	sex	height	weight	temp C	shoe size	shoe size (mm)
Anne	1	1.46	56	36.86	4	245
Tim	2	1.87	80	37.02	10	298
Mathew	1	1.76	86	37.07	8	278
Sheila	2	1.34	58	36.78	5	252
Soraya	2	1.70	72	36.64	6	260
Ben	1	1.77	94	36.97	9	286
Bob	1	1.89	84	37.01	11	305
Sue	2	1.82	65	36.83	8	278
Total?	x	13.61	595	295.18	x	2202
Mean?	x	1.70125	74.375	36.8975	x	275.25
Median?	x	1.765	76	36.915	8	278

8 Resources

Introduction to Level of Measurement Module *URL:* http://courses.csusm.edu/soc201kb/level_of_measurement.htm
Institution iLearn, Cal State, San Marcos
Author: Professor K. Bates
Summary: An online course from Introduction to Statistics for the Social Sciences with examples and tests

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