Levels of Measurement by Heather Wharrad

Learning objective: To understand the four different levels of measurement in order to know how to classify data correctly

www.ucel.ac.uk/rlos/levels_of_measurement/

1 Introduction

We classify data obtained from measurements using numbers and we can do this with different levels of precision or levels of measurement. There are 4 levels of measurement and it is important to know what level of measurement you are working with as this partly determines the arithmetic and statistical operations you can carry out on them. The four levels of measurement in ascending order of precision are, **nominal, ordinal, interval** and **ratio**. As we go on to describe and give examples of each of these levels of measurement, you'll see that the numbers used to describe nominal data are simply used to classify data whereas the numbers describing interval or ratio measurements are much more precise and represent actual amounts.

2 Nominal

At the first level of measurement, numbers are used to classify data. In fact words or letters would be equally appropriate. Say you wanted to classify a football team into left footed and right footed players, you could put all the left footed players into a group classified as 1 and all the right footed players into a group classified as 2. The numbers 1 and 2 are used for convenience, you could equally use the letters L and R, or the words LEFT and RIGHT to label the groups of players. Numbers are often preferred because text takes longer to type out and takes up more space. Another example is blood groups where the letter A, B, O and AB represent the different classes

3 Ordinal

In ordinal scales, values given to measurements can be ordered. One example is shoe size. Shoes are assigned a number to represent the size, larger numbers mean bigger shoes so unlike the nominal scale that just reflects a category or class, the numbers of an ordinal scale show an ordered relationship between numbered items – we know that a shoe size of 8 is bigger than a shoe size of 4. What you can't say though is that a shoe size of 8 is twice as big as a shoe size of 4. So numbers on an ordinal scale represent a rough and ready ordering of measurements but the difference or ratios between any two measurements represented along the scale will not be the same.

As for the nominal scale, with ordinal scales you can use textual labels instead of numbers to represent the categories. So, for example, a scale for the measurement of patient satisfaction with the care they received in hospital might look like this: | Not satisfied | Fairly satisfied | Satisfied | Very satisfied |

There are many everyday examples of measurements assigned to ordinal scales: social class gradings I, II, III, IV; GCSE and A level grades A, B, C, D; house numbers 1,3,5…2,4,6

4 Interval

On an interval scale, measurements are not only classified and ordered therefore having the properties of the two previous scales, but the distances between each interval on the scale are equal right along the scale from the low end to the high end. Two points next to each other on the scale, no matter whether they are high or low, are separated by the same distance. So when you measure temperature in centigrade the distance between 96 and 98^{o}, for example, is the same as between 100 and 102 ^{o}C. Remember though is that for interval scales, a measurement of 100^{o}C does not mean that the temperature is 10 times hotter than something measuring 10^{o}C even though the value given on the scale IS 10 times as large. That's because there is no absolute zero: the zero is arbitrary. On the centigrade scale, the zero value is taken as the point at which water freezes and the 100^{o}C value when water begins to boil and between these extreme values the scale is divided into a hundred equal divisions. (You may remember calibrating water thermometers at school using this method.)

Temperatures below 0^{o} on the centigrade scale are designated negative numbers. So the arbitrary 0^{o}C does not mean 'no temperature'. But when expressed on the kelvin scale, a ratio scale, a measure of 0 K equivalent to -273^{o}C does indeed mean no temperature!

Other examples of interval measurements are rare, but there's one you will be familiar with. Calendar years are an interval scale. The arbitrary 0 (or 1 depending on your viewpoint) was assigned when Christ was born and time before this is labelled 'BC'.

5 Ratio

Measurements expressed on a ratio scale can have an actual zero. Apart from this difference, ratio scales have the same properties as interval scales. The divisions between the points on the scale have the same distance between them and numbers on the scale are ranked according to size. There are many examples of ratio scale measurements, length, weight, temperature on the kelvin scale, speed and counted values like numbers of people, exam marks – a score of zero really does mean no marks!! Returning to the kelvin scale of temperatures, at the temperature of 0 K the lowest temperature possible, it is so cold that all molecules have stopped moving.

6 Scales to classify different measurements

	Nominal	Ordinal	Interval	Ratio
Sex	x			
Hair colour	x			
Pulse				x
Temp. °C			x	
Team number	x			
Shoe size		x		
Footed-ness	x			

7 Assessment – fill in the scales to classify the different measurements

	Nominal	Ordinal	Interval	Ratio
Sex				
Height				
Weight				
Cigarettes				
Exercise				
Year of birth				
Friends				
Fruit/veg				
Health				
Pulse				
Temp.				
Residence				

8 Scales to classify different measurements - answers

	Nominal	Ordinal	Interval	Ratio
Sex	x			
Height				x
Weight				x
Cigarettes		x		
Exercise		x		
Year of birth			x	
Friends	x			
Fruit/veg	x			
Health		x		
Pulse				x
Temp.			x	
Residence	x			

9 Resources

Scales of measurement *URL:* http://web.uccs.edu/lbecker/SPSS/scalemeas.htm
Institution : UCCS Department: *SPSS* Author: *Lee A. Becker*
Summary: Covers scales of measurement, nominal, ordinal, interval and ratio levels. What stats and arithmetic can be carried out at each level.

Levels of measurement *URL:* http://trochim.human.cornell.edu/kb/measlevl.htm
Institution Cornell *Department:* Bill Trochim's Center for Social Research Methods
Author: William M.K. Trochim
Summary: Levels of measurement, nominal ordinal interval and ratio scales from the Research Methods Knowledge Base at Cornell

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