

Measurement Levels – What and Why?

BASICS DATA ANALYSIS T-TEST ANOVA CHI-SQUARE TEST

You are here: [Home](#)

→ [Basics](#) → [Statistics](#)

- [Essential Basics](#) →

[Measurement Levels](#)

– [What and Why?](#)

Measurement levels refer to different types of variables that imply how to analyze them.

Standard textbooks distinguish 4 such measurement levels or variable types. From low to high, these are

1. nominal variables;
2. ordinal variables;
3. interval variables;
4. ratio variables.

The “higher” the measurement level, the more information a variable holds. The simple flowchart below shows how to classify a variable.



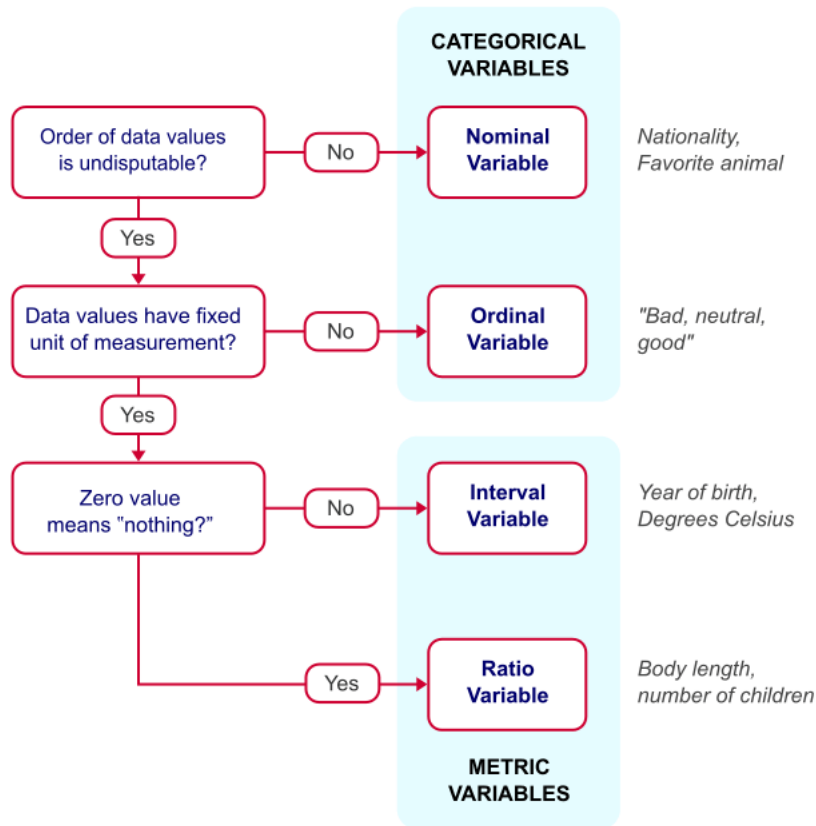
[report this ad](#)

Measurement Levels - Classical Approach



Ne
Tu

MEASUREMENT LEVELS - CLASSICAL APPROACH



Quick Overview of Measurement Levels

Let's now take a closer look at what these variable types really mean with some examples.

AdChoices

Analyzing Data

Levels of Measurement

Length Measurement

Nominal Variables

A nominal variable is a variable whose values don't have an undisputable order.

So let's say we asked respondents in which **country** they live and the answers are

- the Netherlands;
- Belgium;

- France;
- Germany;
- Luxembourg.

So **what's the correct order** for these countries? Well, we could sort them alphabetically, according to their sizes or to numbers of inhabitants. Different orders make sense for a list of countries. In short,

countries don't have an undisputable order

and therefore "country" is a nominal variable.

Now, countries may be represented by numbers (1 = Netherlands, 2 = Belgium and so on) in SPSS or some other data format. These numbers *do* have an undisputable order. But country is still a nominal variable because what's *represented* by these numbers -countries- does not have an undisputable order.

Answer	Frequency	Percent
1 Netherlands	5	3.6%
2 France	21	15.2%
3 Germany	45	32.6%
4 England	39	28.3%
5 Belgium	21	15.2%
6 Luxembourg	7	5.1%
Total	138	100.0%

Country -even if represented as numbers- is still a nominal variable

In a similar vein, ZIP codes -representing geographical areas which don't have a clear order- are nominal as well. But prices in dollars -representing amounts of money- obviously do have an undisputable order and hence are not nominal.

Ordinal Variables

Ordinal variables hold values that have an undisputable order but no fixed unit of measurement.

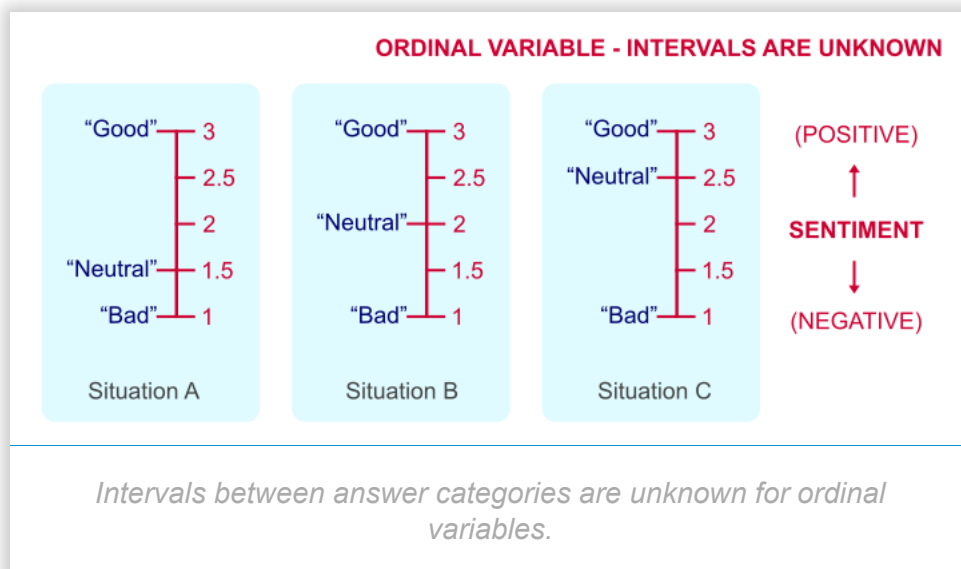
Some fixed units of measurement are meters, people, dollars or seconds. However, there's *no* fixed unit of measurement for a question like

“how did you like your food?”

with the following answer categories:

1. Bad;
2. Neutral;
3. Good.

Some may argue that Bad = 1 point, Neutral = 2 points and Good = 3 points. But that's just a wild guess. Perhaps our respondents feel Neutral represents 1.5 or 2.5 points. This is illustrated by the figure below.



We've no way to prove which scenario is true because just “points” are not a fixed unit of measurement. And since we don't know if Neutral represents 1.5, 2 or 2.5 points,

calculations on ordinal variables are not meaningful.

Less strictly though, calculations on ordinal variables are quite common under the **Assumption of Equal Intervals**.



Also note that **monthly income** measured as

1. Less than € 1000,-;
2. € 1000,- to € 2000,-;
3. € 2000,- or over.

is **ordinal**. Euros are a fixed unit of measurement but the answers are income categories, not numbers of Euros.

Interval Variables

Interval variables have a fixed unit of measurement but zero does not mean “nothing”.

One of the rare examples is “in which **year** did it happen?” Ignoring leap days, years are a fixed unit of measurement for *time*. However, the year zero doesn't mean “nothing” with regard to time.

As a consequence,

multiplication is not meaningful for interval variables.

The year 2000 isn't “twice as late” as the year 1000. The same goes for temperature in degrees Celsius: zero degrees is not “nothing” with regard to temperature. Therefore, 100 degrees is not twice as hot as 50 degrees. This argument *could*, however, be made for temperature in **Kelvin**. We should add that these are the only 2 examples of interval variables we could think of. Interval variables are always analyzed similarly to ratio variables -which we'll turn to next. But distinguishing these as separate measurement levels -all textbooks still do- is pointless.



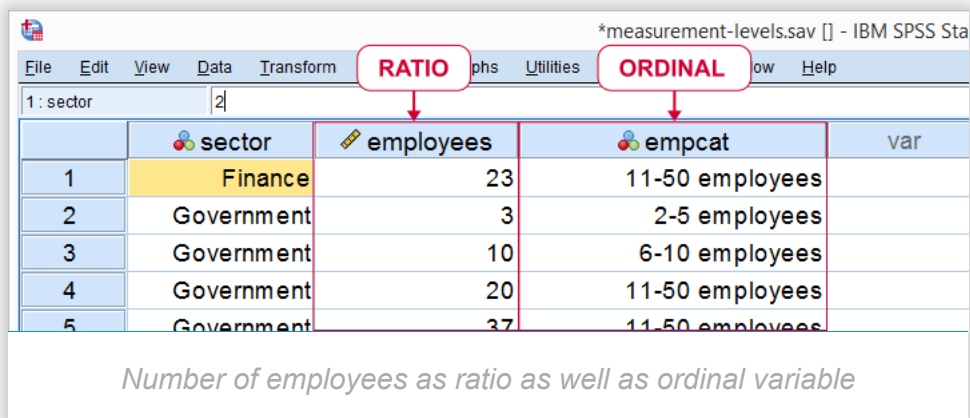
Ratio Variables

Ratio variables have a fixed unit of measurement and zero really means “nothing.”

An example is **weight** in kilos. A kilo is a fixed unit of measurement because it always represents the exact same weight. Also, zero kilos corresponds to “nothing” with regard to weight. As a consequence,

multiplication is meaningful for ratio variables.

In fact, we don't need more than a kitchen scale to prove that 2 times 1 kilo really is the same amount of weight as 1 time 2 kilos.



*measurement-levels.sav [] - IBM SPSS Sta

	sector	employees	empcat	var
1	Finance	23	11-50 employees	
2	Government	3	2-5 employees	
3	Government	10	6-10 employees	
4	Government	20	11-50 employees	
5	Government	37	11-50 employees	

Number of employees as ratio as well as ordinal variable

Some text books mention an “absolute zero point”. We rather avoid this phrasing because ratio variables may hold **negative values**; the balance of my bank account may be negative but it has a fixed unit of measurement -Euros in my case- and zero means “nothing”.

Classical Measurement Levels - Shortcomings

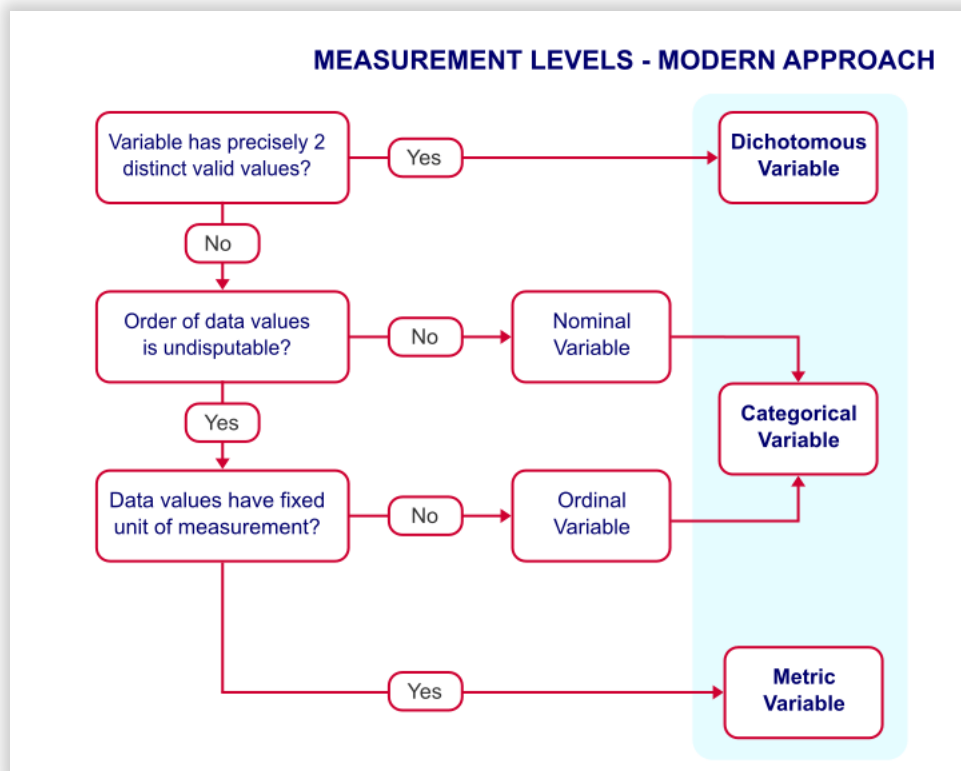
We argued that measurement levels matter because they **facilitate data analysis**. However, when we look at common statistical techniques, we

see that

- **dichotomous variables** are treated differently from all other variables but classical measurement levels fail to distinguish them;
- **metric variables** (interval and ratio) are always treated identically;
- **categorical variables** (nominal and ordinal) are sometimes treated similarly and sometimes not.

Because of these reasons, we think the classification below is much more helpful.

Measurement Levels - Modern Approach



This classification distinguishes 3 main categories which we'll briefly discuss.

Dichotomous Variables

Dichotomous variables have precisely two distinct values.

Typical examples are sex, owning a car or carrying HIV. It is useful to distinguish dichotomous variables as a separate measurement level because they require different analyses than other variables:

- an **independent samples t-test** tests if a dichotomous variable is associated with a metric variable;
- a **z-test for 2 independent proportions** and Phi-coefficient are used to test if 2 dichotomous variables are associated;
- logistic regression predicts a dichotomous outcome variable.

Categorical Variables

Categorical variables are variables on which calculations are not meaningful.

Therefore, nominal and ordinal variables are categorical variables. They contain (usually few) answer *categories*. Because calculations are not meaningful, categorical variables merely define groups. We therefore analyze them with **frequency distributions** and bar charts.

Metric Variables

Metric variables are variables on which calculations are meaningful.

That is: interval and ratio variables are metric variables. Because calculations are allowed, we typically analyze them with descriptive statistics such as

- means;
- standard deviations;
- skewnesses.

Data Analysis - Next Steps

We just argued that

- categorical variables define groups of cases and
- we use descriptive statistics for analyzing metric variables.

Now, say we'd like to know if **2 categorical variables** are associated. Then the first variable defines groups and the second variable defines groups within those groups. A table that shows just that is a contingency table as shown below. It basically holds frequency distributions within frequency distributions

Contingency table employees by sector

		Sector				
		Finance	Government	Industry	Transport	Total
Number of people currently employed	1 employee	0	0	1	0	1
	2-5 employees	3	2	2	1	8
	6-10 employees	1	8	6	0	15
	11-50 employees	25	36	20	5	86
	51(+) employees	3	10	4	0	17
Total		32	56	33	6	127

Next, we could visualize the association with a stacked bar chart. Or we may test if the association is **statistically significant** by running a **chi-square independence test** on our contingency table.

Or perhaps we'd like to know if a categorical variable and a metric variable are associated. The categorical variable defines groups. Within those groups, we'll inspect descriptive statistics over our metric variable. We thus arrive at the table as shown below.

Revenue over 2018 by sector

Sector	N	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Finance	32	\$4,700	\$174,500	\$88,422	\$44,640	-.157	-.582
Government	56	\$8,500	\$217,200	\$97,486	\$42,876	.058	-.109
Industry	34	-\$6,600	\$212,300	\$107,168	\$45,570	-.274	.317
Transport	6	\$53,700	\$111,800	\$92,867	\$20,588	-1.733	3.570
Total	128	-\$6,600	\$217,200	\$97,575	\$43,424	-.078	-.117

We could visualize the means as a bar chart for means by category. Or we could test if the population means differ by category with **ANOVA**.

So now we see how measurement levels help us choose the right analyses. For a more complete overview of analyses by measurement level, see **SPSS Data Analysis - Basic Roadmap**.

Thanks for reading!

Let me know what you think!

Done!

**Required field. Your comment will show up after approval from a moderator.*

This tutorial has 34 comments

By Iwanga on October 31st, 2019

A good explanation. However, may you further simplify it so that people who did not study maths at A-Level may be able to pick it?

Thank you so much



By Santosh Hemrom on September 1st, 2019

Feeling better. Will learn more.



By Rebecca Soto on August 19th, 2019

So very helpful! Easy to understand. Thanks for the help!



By khalid Mohamed on May 13th, 2019

it is nice information



1 ... 7

Get In Touch!

Ruben Geert van den Berg

 **LinkedIn** **Facebook****SPSS Help (Netherlands)**

Sigma Plus Statistiek

www.sigma-plus-statistiek.nl**info@sigma-plus-statistiek.nl****SPSS Help (International)**

SPSS tutorials

www.spss-tutorials.com**info@spss-tutorials.com** **SPSS tutorials**© Copyright Protected 2019 by **Sigma Plus Statistiek****Disclaimer**