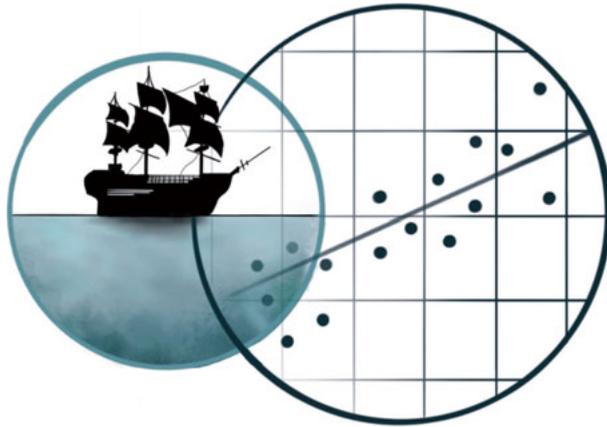


VINCE PENDERS

# PIRATES, PEACHES AND P-VALUES

STYLISH STATISTICS!



**PARRRT 1**

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# THOSE WHO CREATED SALUTE YOU

Welcome, dear reader! A brand-new edition of this handbook is sparkling in your hands, and boy, are we proud of the result. We, the makers, would like to introduce ourselves briefly. Is that all right?



The guy on the left is **VINCE PENDERS**... just call me **Vincenzo**. The brain behind this teaching method – that’s me. Creative to the bone, a cheerful perfectionist. Previously employed at Maastricht University, I work as an independent teacher nowadays, and tutor roughly 300 students per year while constantly improving my book. On those rare occasions when I’m not working or seeing friends, you will find me cooking, playing a Nintendo game, or writing fiction with epic music in my ears. That’s right: novels are my other passion. The upcoming one, *Een beer en een boerka*<sup>1</sup>, tells the tale of a man who believed that he was something small and fluffy. Like my debut novel *Zwaluwhart*, it will be published by Macc in 2020.

My sister **CHELSEY PENDERS** (in front) sings, dances and works as an interior decorator. Where my artistic voice is the written word, hers is the hand-made drawing in every shape and style. She will take on any project that appeals to her visual talents. Chelsy’s versatility is obvious from the many illustrations that populate this book, as well as the slick lay-out with its gorgeous colour schemes (please excuse my lack of pride for her work). Her Maine Coon cats love getting cuddly when she’s drawing at home, so if you spot a cat paw somewhere, make sure to let us know.

And this is **SOPHIA VON STOCKERT**, a former student of mine and a good friend nowadays. She is passionate about research, statistics and writing. A dedicated statistics tutor in the past, she inspired students to get into all the cool stuff that one can do with stats and methods. This is why I brought her on board as an editor of *Pirates, Peaches and P-values*. Sophia holds a Research Master’s degree in Cognitive and Clinical Neuroscience, and currently works as a data analyst in Berlin. In her free time she goes bouldering and reviews and translates books and manuscripts.



What remains are a few honourable mentions as ways to express my gratitude. The first one goes out to Ward Schoonbrood, my good friend who manages the PPP website and is always happy to give me careful advice. The second one is for René Bouman, the publisher who aided us in realising this book. Finally, a big hug to all my students who inspire me every day. Helping you is an honour. You convinced me to write this book and kept my passion burning to improve it further with this new edition. People often thank me for the work I do, but there’s only one proper answer. “No... thank *you!*”

---

<sup>1</sup> Yeah, sorry, it’s currently in Dutch. The title translates to *A Bear and a Burqa*.

# SAILORS' TALES

*PPP battles frustration with a cunning approach to statistics which is entertaining and at the same time simple to understand. The book has sailed with me since day one and regardless of the storm or obstacles ahead, we have always come through.*  
– Christian Feller

*When you're a statistical wreck, his book is the place to be. Its methods have dragged me through my multiple statistics courses time and again.*  
– Niki Ramakers

*Now I think that anyone can really learn statistics... it largely depends on how it's taught.*  
– Fiona Brown

*PPP gave me a new perspective that made it easier for me to grasp difficult concepts and even made learning them fun; who knew stats could be that enjoyable!*  
– Inès Hölscher

*Pirates, Peaches and P-values is a book that everyone in Maastricht has heard of! It does not matter in which café you are sitting; when Vince's book lies on the table, people come to you and ask whether they can have a look in it. PPP takes the fear of statistics away from you immediately.*  
– Mana Shakeri

*I had not done any maths in the last two years of high school and the PPP book helped me out tremendously. I passed my first statistics course with a very high score despite minimal studying thanks to Vince.*  
– Anaïs Vèrny

*The PPP book turns the non-understandable into the understandable, boring numbers into meaningful statistics and stats in general into a course to see through easily and understand instead of passing only with the significant amount of luck. 10/10 buy, absolutely worth it.*  
– David Reinert

*A lifesaver during my graduate studies. Not only did it help me pass my statistics courses, but it also assisted me in planning research proposals.*  
– Faraz Mirza

*Pirates, Peaches, and P-values makes statistics easy to follow no matter what your statistics level is. Great content, layout and creative/fun example questions combined with your own ambition will ensure your success throughout the statistics courses. Highly recommend it!*  
– Katharina Schopen

*Suddenly, dry courses like statistics are not boring anymore.*  
– Thea, Jule, Yasmina

# WHY WOULD YOU USE THIS BOOK?

## DEAR STUDENT,

You probably came here in pursuit of the rumours: rumours about a handbook that does things differently. A teaching method that understands you, that takes you seriously, and that can truly improve your insight. Statistics is a subject you've never asked for; you study Psychology, Medicine or Social Sciences, and are not an expert at mathematics. But since statistics is so important in your field, you can't get around it. Will it ever become more exciting and tangible than a game of  $X$ s and  $Y$ s?

As the responses show: yes. Anyone – and I'm not exaggerating – can see through statistics this way. Before you lies my approach of clear, crazy and complete explanations, translated to paper. You will test cat food, count bananas, observe brave knights and much more. It will make you smarter than you had deemed possible until now.

In short: try it, and be convinced. Help build the revolution, along with the 1600 students that came before you. Still think you're a peach in statistics? You're about to become a pirate!

Greetings,  
Vincenzo

## DEAR TEACHER,

You may open this handbook with a touch of scepticism. Why did such a whippersnapper decide to launch his own teaching method? Should he not have left that to seasoned professors, whose years of teaching and research have allowed them to grow into experts? Really, what has gotten into him, to tempt students into putting aside the recommended literature and change to his unsolicited alternative?

The claim that I possess less expertise than a scientist with a PhD in statistics needs no long debate: you are undoubtedly right. I have a lot to offer, but I know my limits. Perhaps part of my strength arises from this fact. I can empathise with the student, who sometimes has to start from scratch, and often has no sense of mathematics or has yet to develop it. You can guess that I chose unorthodox examples and a light-hearted tone for this very reason. Chances are you will think that both are simply fineries, or even – in the most unfavourable case – that they distract the student from the things he or she should be learning. My view is different. Allow me to provide an explanation.

First, I suspect that *structure* and *a clear overview* are two of the key pillars a student needs. Apart from my examples and style, I have done my best to offer these. Most people experience the organisation of new knowledge as exceptionally challenging, especially if the field does not suit them initially. By conducting some preliminary work, I prevent a lot of frustration. Each chapter begins with sharp tabulated summaries of the theory that is discussed, which show a clear continuity throughout the method: research designs, mathematical formulas, assumptions of statistical tests, and action plans for an analysis are mentioned point by point. The general *Action Plan for Analyses*, found in the Appendix module of Parrrt 2, offers further support in developing a bird's-eye view, and can be used at later stages as well by students and researchers to properly steer their statistics. You may hold the opinion that I take too much work out of the students' own hands. In my own experience, however, they learn

most effectively if they are presented with this structure at least once. In contexts that allow for interaction, such as a lecture or lesson, a middle road can be walked which is the optimum in my view: together with the teacher, the students will then fill in the summaries themselves. I also advise readers of this handbook to do the same thing in their own notes (see *How to use this book?*).

Second, I am convinced that a teaching method for statistics should be both accessible and complete. Accessible in the sense that anyone should understand it; complete in the sense that it skips as few steps as possible. Roughly, statistical education knows two excesses. One excess is the ‘just take this formula and fill it in’ approach; you spare the student the details, but he or she still has no idea what it is actually about and remains deprived of true insights. At the other end we find formal mathematical definitions, where abstract language, matrices, proofs and subscripts build a heavily fortified castle without a visitor’s entrance – and never forget: the student is a visitor in the statistical universe, an immigrant who still has to find his way. Neither of these extremes please me. This book is a roadmap which seeks to stop by a great many locations, using paths without pitfalls, and with tips for the connoisseur. When a formula presents itself, I will tell you how it was constructed; if a statistical test makes a certain assumption, I will explain why. Should a problem truly carry too far for a regular course in statistics, I will offer the solution in footnotes and bonus sections for the reader who wants to go the extra mile. Many students (especially from university) find it hideous to just assume things; they prefer to go through fire and water and root their knowledge into solid ground – so afterward, they will retain that knowledge better, guaranteed.

Third, all my examples are parodies on existing research. When designing a new one, I always ask myself the same question. Will this parody help or will it distract? Is it a bizarre attempt to be interesting, or can a student really learn from it? Of course some will raise their eyebrows when asked to experiment on mermaids, observe extraterrestrial seagulls, and hand out questionnaires to grumpy orcs. Why does this method not cut to the chase? But soon these same students discover how the data come to life inside their heads. Relationships and effects take shape in their imagination, and at this point, I give those relationships and effects a statistical face. Students start to see what this mathematical gibberish is supposed to say, what significance and confounding and interaction mean. The irony? They do not learn in spite of, but *thanks to* the cheerful examples, which to them are infinitely more tangible than a variable  $X$  and a variable  $Y$ . And when he or she later tries to remember how multiple regression went again, which memory might surface faster? ‘Oh, that thing with the  $X$ s!’... or rather: ‘Oh, that thing with the pirates!’?

In short: *Pirates, Peaches and P-values* wants to build bridges. A bridge between exhaustiveness and accessibility, one between substance and mathematics, and one between comedy and knowledge. And let us not forget: a bridge between teachers. As I frankly admitted earlier, your expertise in statistics is larger than mine. Thus, this book has been designated for mutual cooperation from its first paragraph. I think that you and I can complement each other from our own specialty, to finally rob the subject of statistics from its persistent status of ‘difficult’ and ‘boring’. Should you see conditions arise on which this teaching method would be a valuable addition to your curriculum, please do not hesitate and contact us via [www.pppwaarden.nl](http://www.pppwaarden.nl). I look forward to our first conversation.

Warm regards,  
Vince Penders

# HOW TO USE THIS BOOK?

*Pirates, Peaches and P-values* is able to function as an independent course in statistics. In practice, most readers will probably use it to support them during a college or university programme. That's why, from this edition onward, we've split the book into **two volumes**:

- ◆ **Parrrt 1** covers the fundamentals. Describing samples, probability theory, hypothesis tests, confidence intervals... You're likely to find this volume useful if you're a college student, or in your first year of university.
- ◆ **Parrrt 2** opens up the full arsenal. Statistical models with more than two variables, repeated measures designs, psychometrics... Head for these waters in your second year of university and beyond.

Of course this is just a general guideline. Individual curricula may discuss some topics from Parrrt 2 in college, or come back to stuff from Parrrt 1 during the second university year. Researchers (and perfectionistic students) may want to possess both books so that they can read up on the fine details. Note that those who only have Parrrt 2 need not fret: many key concepts from Parrrt 1 are summarised in the *Overviews and Core Concepts* section! Make sure to use it for a smooth experience. ☺

Apart from theoretical explanations, most chapters in *PPP* also offer **exercises**. I have designed them to not only test your knowledge, but add deeper layers to it as well. So practice! Well-made exercises are educational and add a lot to your hands-on experience.

If you find that something crucial is **missing** from this handbook, let us know via [www.pppwaarden.nl](http://www.pppwaarden.nl)! We look forward to making the next version even more complete.

## DO YOU STUDY STATISTICS INDEPENDENTLY?

Just start at chapter 1 or at the topic you'd like to learn something about. See the next heading for following considerations.

## ARE YOU TAKING A STATISTICS COURSE AT YOUR SCHOOL, COLLEGE OR UNIVERSITY?

Go to the table of contents and look for the subject you need to study. If you can't find it, consult the index at the end of the book. There is also a chance that **Parrrt 2** features your topic instead!

Found it? The prerequisite knowledge is always listed at the beginning of the chapter. Start by reading the theory with a good cup of coffee or tea, and take notes. Copy down the overview section, but leave most boxes empty and try filling them in while reading. Then proceed to the exercises to put your newborn knowledge to the test. The solutions are freely accessible on the website.

By no means be discouraged if you don't do well at the exercises right away. Statistics needs attention and practice. Sometimes things will go much better one day later, when the new information has settled a bit. Good luck! ☺

## DO YOU NEED STATISTICS FOR YOUR OWN RESEARCH?

You are probably familiar with the topics I discuss in this book. Use the flowchart in the Appendix to choose the right statistical analysis, then go through the corresponding chapter. Between the lines you will find instructions to command SPSS as well. *How to use this book?* in **Parrrt 2** offers further suggestions.

# DESCRIBING DATA

In quantitative research, the collection and analysis of data play an important role. This first part teaches you to organise and describe data optimally. Count ice cream servings, visit a haunted house and spice up your romantic dinner; a good beginning is half the work. A new world is waiting for you!



## Chapter 1

# CHARTING DATA

### 1.1 OVERVIEW

**Instruction:** the overview section of each chapter is not meant to teach you completely new things, but rather to provide a clear summary of the key components. Use it to study after reading the chapter, and to look up important details quickly.

LEVEL	PREREQUISITES
Cupcake	None (this is the first chapter, you know 😊)

#### VARIABLES AND LEVELS OF MEASUREMENT

GENERAL	SPECIFIC	WHAT'S THAT SUPPOSED TO BE?
<b>Categorical</b>	<b>Nominal:</b> <i>naming</i>	Equal categories, such as gender (male/female). Special case: dichotomous (only two categories).
	<b>Ordinal:</b> <i>ordering</i>	Ordered categories, such as level of education (low/middle/high).
<b>Quantitative</b>	<b>Interval:</b> <i>distance</i>	Meaningful numbers, such as IQ (50-150). That's because the distance between consecutive units is always equally large (in principle).
	<b>Ratio:</b> <i>rate</i>	An interval variable with an absolute zero point, such as age. Distinguishing ratio from interval isn't crucially important.

LEVEL OF MEASUREMENT	SUITABLE TABLES	SUITABLE GRAPHS	SUITABLE MEASURES OF CENTRAL TENDENCY	SUITABLE MEASURES OF DISPERSION
Nominal	Frequency table	Pie chart / bar chart	Mode	<i>none</i>
Ordinal		Bar chart	Mode Median	
Interval	Stem-and-leaf plot	Histogram	Mode Median Mean	Interquartile range (IQR) Standard deviation <sup>2</sup>
Ratio				

#### MEASURES OF CENTRAL TENDENCY, DISPERSION ET CETERA

The *i* in some of these formulas stands for the participant.

MODE	
Central tendency: the score that occurs the most often.	
<b>Calculation</b>	Not needed. Just take the score that occurs the most often.
<b>Usage</b>	Always okay. Tells you something about the <u>frequency</u> of scores. Report not one but two modes if you have a bimodal distribution (two peaks).

<sup>2</sup> If we report the median as the measure of central tendency, the accompanying measure of dispersion should be the interquartile range (careful: the IQR is possible only for quantitative variables). The mean should be accompanied by the standard deviation.

**MEASURES OF CENTRAL TENDENCY, DISPERSION ET CETERA (continued)**

<b>MEDIAN</b>	
Central tendency: the middle score (50% lies below and 50% above).	
<b>Calculation</b>	Order the scores from lowest to highest and find the middle one using $\frac{N+1}{2}$ . Should you get a whole value (also called an integer, say 6), you had an odd number of scores. Find the score in the integer's position (the 6 <sup>th</sup> one in this case). Should you get a value with a decimal (say 6,5), you had an even number of scores. Take the average of the 6 <sup>th</sup> and 7 <sup>th</sup> score (in this case)
<b>Usage</b>	Okay for ordinal variables and up. Tells you something about the <u>frequency</u> and <u>order</u> of scores. Also usable for skewed data and outliers (is resistant). Report not one but two medians if you have a bimodal distribution: one per subgroup.
<b>(ARITHMETIC) MEAN</b>	
Central tendency: the scores' centre of mass.	
<b>Calculation</b>	$\bar{X} = \frac{\sum X_i}{N}$ In words: sum all the scores and divide them by the total number of scores.
<b>Usage</b>	Okay for interval variables and up. Tells you something about the <u>frequency</u> , <u>order</u> , and <u>value</u> of scores. Be careful using it in case of skewed data or outliers (is not resistant). Report one per subgroup for bimodal distributions.
<b>STANDARD DEVIATION</b>	
Dispersion: the average deviation from the mean. The squared value of this ( $s_x^2$ ), calculated in step 2, is called the variance.	
<b>Calculation</b>	$s_x = \sqrt{\frac{\sum (X_i - \bar{X})^2}{N - 1}}$ 1) Take the difference of each score from the mean, square the outcomes and sum them; 2) Divide them by the total number of scores minus 1; 3) Take the square root of the result.
<b>Usage</b>	Okay for interval variables and up. Be careful using it in case of skewed data or outliers (is not resistant). Report one per subgroup for bimodal distributions.
<b>QUARTILES</b>	
$Q_1$ is the first quartile, also called the 25 <sup>th</sup> percentile: it divides the lower 25% of the scores from the upper 75%. $Q_2$ is the second quartile or 50 <sup>th</sup> percentile: it divides the lower 50% of the scores from the upper 50%. $Q_3$ is the third quartile a.k.a. the 75 <sup>th</sup> percentile: it divides the lower 75% of the scores from the upper 25%.	
<b>Calculation</b>	First, order the scores from lowest to highest and find the 'ordinary' median. This is in fact $Q_2$ . Then find the median of the values <u>below</u> $Q_2$ : this is $Q_1$ . The median of the values <u>above</u> $Q_2$ – you guessed it – is $Q_3$ .
<b>Usage</b>	Okay for ordinal variables and up.
<b>INTERQUARTILE RANGE (IQR)</b>	
Dispersion: the range of the 50% middle scores.	
<b>Calculation</b>	$IQR = Q_3 - Q_1$
<b>Usage</b>	Okay for interval(!) variables and up. Also usable with skewed data and outliers (is resistant).
<b>FIVE-NUMBER SUMMARY</b>	
Five quantities in a row that summarise the complete distribution: the minimum, $Q_1$ , the median, $Q_3$ , and the maximum.	
<b>Calculation</b>	As above (for the quartiles). Outliers don't need to count as minimum or maximum value (but they can; it's up to you).
<b>Usage</b>	Okay for interval variables and up.
<b>1,5*IQR CRITERION</b>	
Criterion to identify a score as an outlier. (Other criteria are possible as well; see chapter 20 in Parrt 2.)	
<b>Calculation</b>	Calculate the following bounds: $Q_1 - (1,5 * IQR) \quad \text{and} \quad Q_3 + (1,5 * IQR)$ If a score falls outside this range, we consider it an outlier.
<b>Usage</b>	Okay for interval variables and up.

**DATA TRANSFORMATIONS: LINEAR**

In these formulas,  $i$  stands for the participant.

NAME	I BEG YOUR PARDON?	CALCULATION
<b>Multiplying</b>	Multiply all scores by a certain number.	$X'_i = m * X_i$ ( $m$ is a number, say 10)
<b>Centring</b>	Shift all the scores such that the mean becomes 0.	$C_i = X_i - \bar{X}$
<b>Standardising</b>	Centre, then multiply: shift all the scores such that the mean becomes 0, and then turn the standard deviation into 1.	$z_i = \frac{X_i - \bar{X}}{s_X}$

**1.2 SO MANY FLAVOURS: VARIABLES**

This first chapter will explore how we can visualise data clearly, summarise what happens in a data set, and fish out striking values. Sounds scary and abstract? Ah, but's all right to make mistakes, dear reader... and you are mistaken: it's gonna be friggin' awesome. ☺ Let's make things tangible straight away. Ice cream flies across the counter in ice cream parlour Peach's Castle. Especially in the high season, customers are hard to keep up with. Let's take a sample of ten servings of ice cream sold today, to get an idea of the most popular flavours and kinds. Granted, a bigger sample would be more representative, but this scale's a bit easier to handle for an introduction chapter. We take note of the following things:

- ❖ What flavour does the ice cream have: vanilla, chocolate or peach (the specialty of Peach's Castle)?
- ❖ In what kind of cone is the ice cream served: a mini cup, a standard cornet or a giant cone?
- ❖ At what temperature (in degrees Celsius) is it served?
- ❖ How many scoops does the customer buy?

The properties above will differ per customer. That's why we call the number of scoops, the flavour and so on **variables**: quantities the value of which varies, in this case depending on the participant. The variables we've just listed are not of the same nature. Each has its own **level of measurement**:

**I. NOMINAL**

This level of measurement belongs to the general type of **categorical** (or qualitative) variables and stands for 'naming'. Which flavour does the ice cream have? Possible answers are 'peach', 'chocolate' and 'vanilla'. These answers don't contain a rank order; they're equal categories. We can assign a number to each of them, but this number won't mean anything by itself.

Nominal variables you often find in social research are binary gender (male or female)<sup>3</sup>, nationality (Dutch, German, French et cetera), and religion for example (none, Christian, Islamic and so on). Incidentally, they're sometimes labelled according to the number of categories they have: **dichotomous** (2; 'two-valued'), **trichotomous** (3; 'three-valued') or **polytomous** (more than 3; 'many-valued').

**II. ORDINAL**

This level of measurement is still **categorical** too, and stands for 'ordering'. In which kind of cone is the ice cream served? Possible answers are 'mini cup', 'standard cornet' and 'giant cone'. These categories contain a clear order, since the cone keeps getting bigger. We could assign numbers to them, such as 1, 2, 3. The higher the number, the higher the rank of the cone (so, its size). But the difference between 1 and 2 (mini cup versus standard cornet) is not necessarily as large as the difference between 2 and 3 (standard cornet versus giant cone). Thus the numbers still don't mean anything by themselves. Typical ordinal variables in social research are level of education (often grouped as low, middle and high), income group (lower, middle and upper class), and employee status (worker, manager, director).



<sup>3</sup> This is the traditional view, but the perspectives on gender are changing toward an interval spectrum. Hurts nobody, does it? ☺

### III. INTERVAL

This level of measurement is the first one of the **quantitative** levels; ‘interval’ is another word for ‘distance’. At what temperature is the ice cream served? We measure the answer in degrees Celsius<sup>4</sup> and the difference (the distance) between 0 and 1 degrees is equally large as the difference between 3 and 4 degrees. This imbues the numbers with a true quantitative meaning. Social studies measure many personality traits that we cannot directly ‘see’, such as intelligence and extraversion; they use tests and questionnaires for this. The abstract test score is often an interval scale. Think of IQ (50-150).

### IV. RATIO

Also a **quantitative** type. How many scoops of ice cream does the customer buy? This is an interval variable with an absolute zero: it is possible to buy 0 scoops, and to score less than zero is impossible. As a result it makes sense to start talking about ratios (rates): four scoops are twice as many as two scoops, for example. This doesn’t apply to interval variables; for instance, you can’t say that 6 degrees Celsius are twice as hot as 3 (precisely because you can go below zero as well). For statistics, the distinction between interval and ratio variables will hardly ever matter. Other examples from social studies include many phenomena from the natural world, such as age, body weight and reaction time.

The measurement level of a variable determines how we can summarise and visualise the scores on that variable. In later chapters, the level of measurement will determine which statistical tests we can unleash at a variable. Thus, levels of measurement are both easy and crucial!

## 1.3 MAKING THE MENU: TABLES AND GRAPHS

Going back to the study, we have tracked ten orders in total. If we document everything in an Excel or SPSS file, the following table results. Note: one customer didn’t appreciate us sticking a thermometer into his ice cream in order to measure its temperature. Consequently, the temperature of his ice cream sadly remained unknown. The incident pissed him off, so he also didn’t show us the size of his cone.

ICE CREAM NUMBER	FLAVOUR	CONE	TEMPERATURE	SCOOPS
1	peach	giant cone	-0,4	3
2	vanilla	mini cup	-2,2	1
3	vanilla	???	???	4
4	peach	standard cornet	0,4	2
5	peach	standard cornet	-1,9	2
6	peach	mini cup	-1,4	2
7	chocolate	standard cornet	-2,8	3
8	peach	standard cornet	-2,5	2
9	peach	giant cone	-0,3	8
10	vanilla	standard cornet	-1,4	3

That’s how you usually begin as a researcher... with a bloody mess. ☹ Let’s see if we can display the results of our measurements a bit more attractively and clearly. We’ll deal with the variables one by one.

### I. NOMINAL VARIABLES

The scores on categorical variables can be well presented in a **frequency table**: a table that indicates for each category how often it has been scored. The next page displays it for you. We see that out of the ten ice cream servings (total), 6 tasted like peach, 1 like chocolate, and 3 like vanilla. Those 6 constituted 60 percent of the total. In other words, more than half of the customers have chosen the specialty of Peach’s Castle.

<sup>4</sup> “But I’m a proud American, Vincenzo! What about Fahrenheit?” It works the same way for that scale, dear reader.

		Frequency	Percentage
FLAVOUR	peach	6	60,0
	chocolate	1	10,0
	vanilla	3	30,0
TOTAL		10	100,0

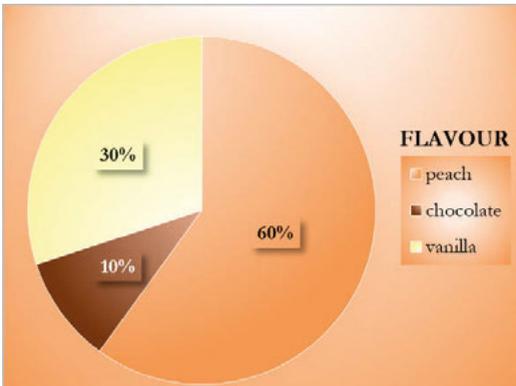


FIGURE 1.1

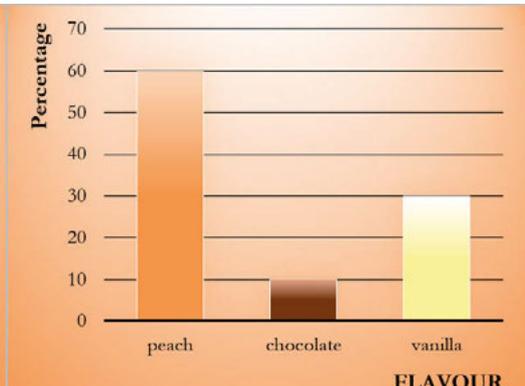


FIGURE 1.2

We can also visualise this in a **pie chart** (FIGURE 1.1) or a **bar chart** (FIGURE 1.2). The pinkish orange piece of the pie stands for the part of peach-flavoured ice cream servings – more than half, as can be clearly seen. A small part tastes like chocolate and well over a quarter like vanilla. In a bar chart we see bars which indicate the number of ice cream servings within a flavour category – or the height of the percentage, depending on our choice.

## II. ORDINAL VARIABLES

This type of variables is categorical as well, so a frequency table is pretty suitable in any case.<sup>5</sup> Behold:

		Frequency	Percentage	Cumulative percentage
CONE	mini cup	2	22,2	22,2
	standard cornet	5	55,6	77,8
	giant cone	2	22,2	100,0
TOTAL		9	100,0	

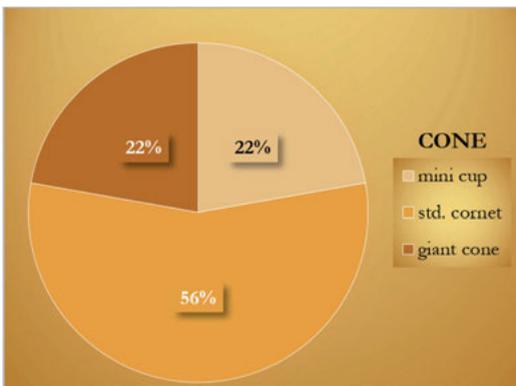


FIGURE 1.3

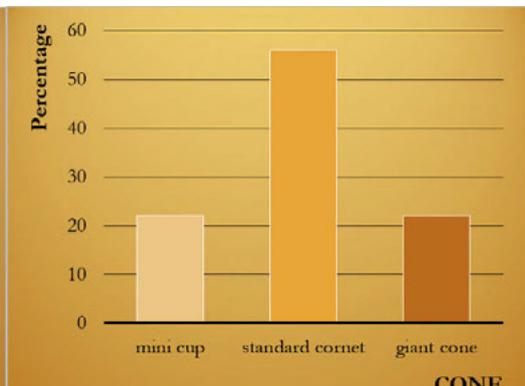


FIGURE 1.4

<sup>5</sup> “Vincenzo, I used a computer program and my table also contains a column labelled *Valid Percent*. What’s that?”

If the data file contains no valid score for a participant on the variable, we speak of a missing value. In the calculation of the valid percentage, only the participants with a valid score have been counted.

# INDEX

This list indicates the number of the section where the concept is introduced and/or covered extensively. You can always find it in the text by looking for a **bold term**.

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