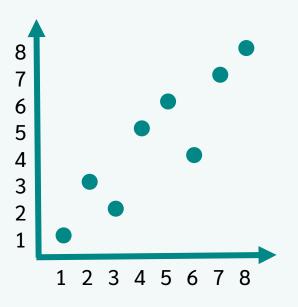


SPEARMAN CORRELATION Playbook

Theory & Example

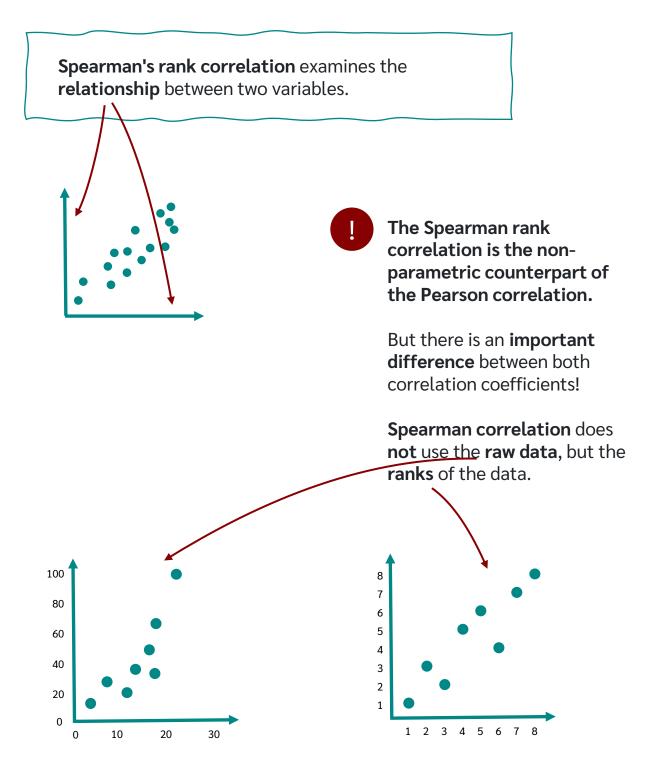


Author: Dr. Mathias Jesussek ©DATAtab e.U. | Graz | 2023



What is a **Spearman** correlation?









Example:		$\overline{\mathbb{Q}}$	ħ
We measured the reaction		12	14
time of 8 computer players		15	25
and asked their age .	T	17	20
3		18	35
	Ť.	20	45
	Ť	21	30
	Ť.	22	60
	Ť	26	95

When we calculate a **Pearson correlation**, we simply take the two variables **reaction time** and **age** and calculate the **Pearson correlation coefficient**.

$$r=rac{\sum (x_i-ar{x})(y_i-ar{y})}{\sqrt{\sum (x_i-ar{x})^2\sum (y_i-ar{y})^2}}$$

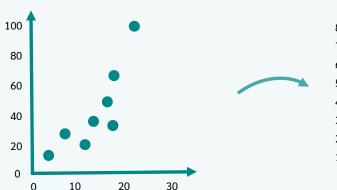


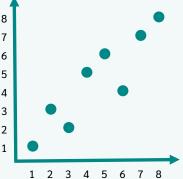
However, we now want to calculate the **Spearman rank correlation**, so first we assign a **rank** to each person for **reaction time** and **age**.

> The **reaction time** is already sorted by size. **12** is the smallest value, so gets **rank 1**; **15** is the second smallest, so gets **rank 2** and so on and so forth.

We are now doing the same with **age**. **14** is the smallest value so gets **rank 1**; **25** is the third smallest and gets **rank 3**; **20** is the second smallest an gets **rank 2**, and so on and so forth

Let's take a look at this in a **scatter plot**. Here we see the raw data of **age** and **reaction time:** But now we would like to use the **rankings**. So, we **form ranks** from the variables **age** and **reaction time**:





12

15

17

18

20

21

22

26

1

2

3

4

5

6

7

8

14

25

20

35

45

30

60

95

1

3

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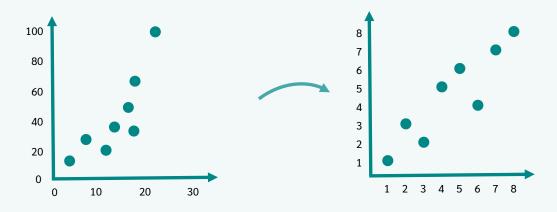
8





Through this **transformation**, we have now distributed the data more evenly.

To calculate the **Spearman correlation**, we simply calculate the **Pearson correlation** from the **ranks**.



So, the **Spearman correlation** is equal to the **Pearson correlation**, only that the r**anks** are used instead of the **raw values**.



Have a quick look at this in **DATA**tab



Metric Variables:	Ordinal Variables:	Metric Variables:	Ordinal Variables:	Nominal Variable
Reaction time Age Ranks reaction time		Reaction time Age		
Ranks age		Ranks reaction time Ranks age		
Calculate:		Calculate:		
○ Pearson Spearman Kendall's tau		Pearson O Spearman O Kendali's tau		
Two-tailed One-tailed		Two-tailed One-tailed		
Level of significance:		Level of significance:		
0.05		0.05		
Spearman Correlation Analysis		Pearson Correlation Analysis		
Effect size 🙆 Summary in words 🖥		Test assumptions	•	
Hypotheses		Hypotheses		
Copy 🖥 Settings 🌣		Copy 🖥 Settings 🌣		
Null hypothesis	Alternative hypothesis	Null hypothesis	Alternative hypothesis	
There is no association between Reaction time and Age	There is a association between Reaction time and Age	There is no association between Ranks reaction time a Ranks age	nd There is a association between Ranks reactio Ranks age	n time and
Valid cases				
Copy 🖥 Settings 🌣		Valid cases		
Valid cases		Copy 🖥 Settings 🏚		
Number 8		Valid cases		
		Number 8		
Correlation				
Copy 🖥 Settings 🏚		Correlation		
r p (2-tailed)		Copy 🖥 Settings 🏚		
Reaction time and Age 0.9 .002		r p (2-taile	ed)	
		Ranks reaction time and Ranks age 0.9 .002		

Spearman Correlation

Pearson Correlation

Now we can either calculate the **Pearson correlation** of the reaction time and the age where we get a **correlation of 0.9**.

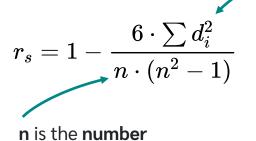
Or we can calculate the **Spearman correlation** from the ranks, there we also get **0.9**.

So, exactly the same as before.



If there are **no rank ties**, we can also use this **equation** to calculate the **Spearman correlation**.

of cases



 d is the difference in ranks between the two variables.

Referring to our example:

we get the different d's with this: 1-1 = 0, 2-3 = -1, 3-2=1, and so on. Now we square the individual d's and add them all up.	12 1 15 2 17 3 18 4 20 5 21 6 22 7 26 8	14 1 25 3 20 2 35 5 45 6 30 4 60 7 95 8	d $1-1 = 0$ $2-3 = -1$ $3-2 = 1$ $4-5 = -1$ $5-6 = -1$ $6-4 = 2$ $7-7 = 0$ $8-8 = 0$	d ² 0 1 1 1 1 4 0 0
$r_s=1$ n, which is the number of people, is 8.	$-\frac{6\cdot \sum d_i^2}{n\cdot (n^2-1)}$		-	Σ 8
If we put everything in, we get a correlation $r_s=1$ coefficient of 0.9.	$- rac{6 \cdot \sum d_i^2}{n \cdot (n^2 - 1)}$	= 1 -	$\frac{48}{504} = 0.90$)



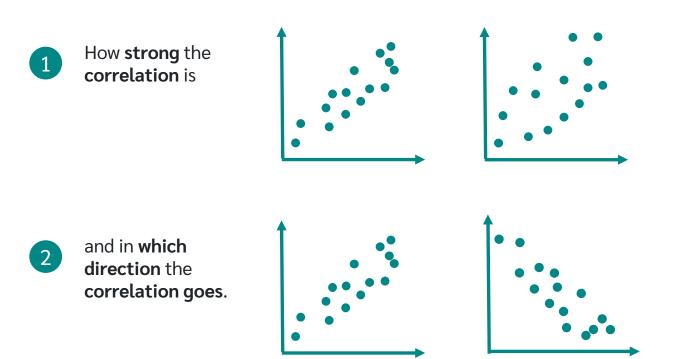


1

0

Just like the Pearson correlation coefficient r the Spearman correlation coefficient r_s also varies between -1 and 1.

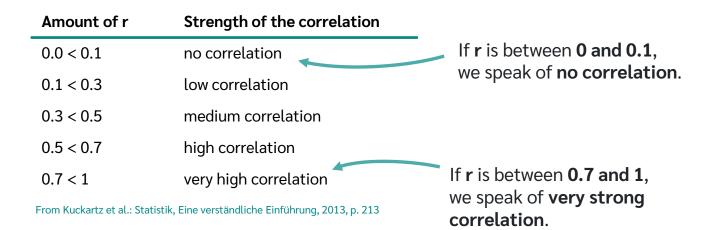
With the help of the **coefficient**, we can now **determine two things**.



-1







If we have a coefficient **between -1 and less than 0**, there is a **negative correlation**, If we have a coefficient **between** greater than 0 and 1, there is a positive correlation,







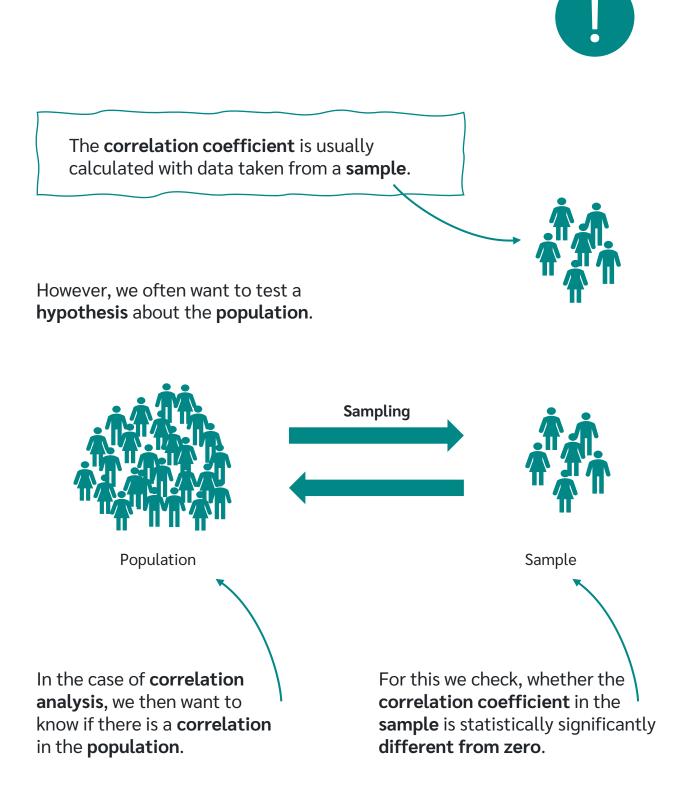
thus a **negative relationship** between the variables.

-1

thus a **positive relationship** between the variables.

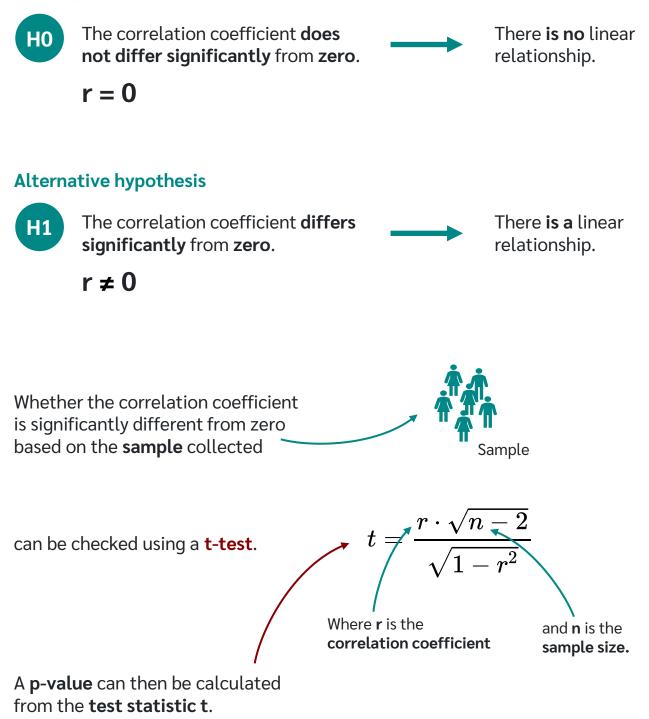
If the result is **0**, we have **no correlation**.







Null hypothesis



If the **p-value** is less than the specified **significance level**, which is **usually 5%**, then the **null hypothesis** is rejected, otherwise it is not.



Referring to our example:



If we use **DATA***tab* for the calculation of the example, we get a **p-value of 0.002**.

The **p-value** is therefore **smaller than 0.05** and we can therefore **reject the null hypothesis** that in the population the correlation coefficient is zero.

Descriptive Charts Hypothesis tests Correlation	n Regression	Mediation/Moderation	PCA	Reliability	Cluster	Ð
Metric Variables: Reaction time Age Ranks reaction time Ranks age Calculate: O Pearson O Spearman O Kendall's tau	Ordinal Variables:			Nominal Va	riables:	
 Two-tailed O One-tailed Level of significance: 0.05 Spearman Correlation Analysis Two-tailed 						
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There is no association between Reaction time and Age	There is a associa	ation between Reaction time	and Age			
Copy Settings Copy Valid cases						
Correlation Copy Settings r p (2-tailed) Reaction time and Age 0.9 .002						





How do we calculate a **Spearman correlation** with **DATA**tab?

← → ♂ (i datatab.net)intristics-calculator/hypothesis-test	ය ස 🛪 🗄 🛙 🥥	
Spearman Correlation Analysis		If you like, you also can calculate the
Effect size 🕢 Summary in words 🗋	-	Spearman correlation with DATAtab
Hypotheses		
Copy 🖥 Settings 🌣		
Null hypothesis	Alternative hypothesis	
There is no association between Reaction time and Age	There is a association between Reaction time and Age	
Valid cases Copy B Settings Valid cases Number 8		<u>GO TO DATAtab</u>
Correlation		
Copy 🖥 Settings 🌣		
r p (2-tailed)		
Reaction time and Age 0.9 .002		

How-to

To get a correlation analysis of our data, just copy your data into this <u>table</u> on **DATA**tab and click on either the Hypotheses or Correlation tab.

	arma	n Co	rrelation	on Calo	culato	or		
							or metric variable	s. Just try it
ne samp	ole data abo	ve. If you sel	ect two metric	variables, you	still have to c	lick on Spearn	nan Correlation.	
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	· ·····	* mattic	· metric	· correct	* metra	· mented	* ordinal	
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1	Female	1,500	33	Chicago	80	BMW	Bachelor	1
2	Female	1,200	33	Chicago	82.5	Ford	No	
- 3	Male	2,200	34	New York	100.8	BMW	Bachelor	
-4	Male	2,100	42	New York	90	BMW	Mæster	
5	Female	1,500	29	Chicago	67	Ford	Master	
6	Fernale	1,700	19	Washington	60	Ford	Master	
7	1.faie	3,000	50	Washington	77	Ford	No	
8	Male	3,000 2,800	55	Washington	77 87	Ford	Bachelor Bachelor	1
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More about SPEARMAN CORRELATION

on our website datatab.net

