

Spearman's rank correlation coefficient

About 50 minutes Calculator allowed 44 marks



Hints online, answers free with an account:
mathswariz.uk/worksheets/stats-spearman-s-rank-correlation-coefficient/

Date _____

A Do Now

The first question is what today's lesson needs. The others bring back earlier topics.

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| <p>A1 Needed today [2 marks]</p> <p>Data from 24 weeks show strong positive correlation between the number of fans sold and the number of visits to the swimming pool. Noor says "When the number of fans sold is high, the number of visits to the swimming pool tends to be low." Is Noor right? Give a reason.</p> <p>_____</p> | <p>A2 Last lesson [2 marks]</p> <p>For four cars, x is the age in years and y is the price in £100s: (27, 13), (2, 41), (20, 79), (15, 71). A line of best fit is to be drawn. Work out the coordinates of the point it must pass through.</p> <p style="text-align: right;">Answer</p> |
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| <p>A3 From chapter 8 [2 marks]</p> <p>A control chart for tubes of glue has target 120 ml, warning limits 117 and 123, and action limits 115.5 and 124.5. The last two sample means were 121.2 and then 123.3 ml. What should be done now? Give a reason.</p> <p>_____</p> <p>_____</p> | <p>A4 Maths skill [2 marks]</p> <p>There are 280 people at a concert. $\frac{3}{4}$ of them are adults and $\frac{5}{7}$ of the adults are women. How many women are at the concert?</p> <p style="text-align: right;">Answer</p> |
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B Examples, then your turn

Your teacher works through each example with you. Then try the one beside it. Spearman's rank correlation coefficient is $r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$, where d is the difference between the two ranks and n is the number of pairs.

EXAMPLE 1

Two judges rank six dogs in a show. Work out Spearman's rank correlation coefficient. Give your answer to 3 decimal places.

Dog	A	B	C	D	E	F
Judge 1	1	2	3	4	5	6
Judge 2	2	1	4	3	6	5

Hint Find d for each dog, square each one, then add.

B1 Two judges rank seven paintings, A to G. Judge 1: 3, 1, 4, 2, 6, 7, 5. Judge 2: 2, 1, 5, 4, 7, 6, 3. Work out Spearman's rank correlation coefficient. Give your answer to 3 decimal places. [3 marks]

Answer

EXAMPLE 2

The table shows the maths and science marks of six students. Rank each set of marks, with the highest mark as rank 1. Work out Spearman's rank correlation coefficient. Give your answer to 3 decimal places.

Student	P	Q	R	S	T	U
Maths	45	62	38	71	55	80
Science	52	58	41	77	60	74

Hint Rank the maths marks on their own, then the science marks on their own.

B2 Seven students recorded the number of days they were absent and their test score. Days absent: 2, 5, 3, 8, 6, 1, 4. Test scores: 48, 28, 41, 22, 30, 55, 36. Work out Spearman's rank correlation coefficient. Give your answer to 2 decimal places. [4 marks]

Answer

EXAMPLE 3

Eight hotels are ranked by price (most expensive is 1) and by the rating guests give (highest rating is 1). Spearman's rank correlation coefficient is -0.75 . Interpret this value in context.

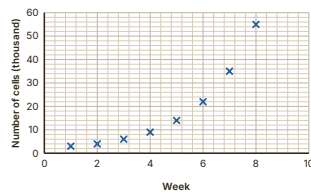
Hint Say how strong it is and which way, then what it means for price and rating.

B3 For 10 students, Spearman's rank correlation coefficient between the distance they live from school and their position in a test is -0.12 . Interpret this value in context. [2 marks]

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EXAMPLE 4

The scatter diagram shows the number of cells in a sample over 8 weeks. Spearman's rank correlation coefficient is 1. Explain why, when the points do not lie on a straight line.



Hint Look at what happens to the number of cells each week. Then think about the ranks.

- B4** A judge ranks 8 cakes from best to worst. The price of each cake is also recorded. Give a reason why Spearman's rank correlation coefficient is used, not the product moment correlation coefficient. [1 mark]
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c Practice

- C1** Six runners' times, in seconds, are 12.4, 11.8, 13.1, 12.0, 11.5, 12.9. Rank the times, with the fastest as rank 1. Write the ranks in the same order as the times. [2 marks]
- Answer ... , ... , ... , ... , ... , ...
- C2** For 8 pairs of ranks, $\sum d^2 = 30$. Work out Spearman's rank correlation coefficient. Give your answer to 3 decimal places. [2 marks]
- Answer
- C3** Mo works out Spearman's rank correlation coefficient for some data and gets 1.15. Explain how you know he has made a mistake. [1 mark]
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- C4** Three judges, A, B and C, rank the same 10 singers. Spearman's rank correlation coefficient is 0.45 for A and B, 0.91 for A and C, and 0.38 for B and C. Which two judges agree most? Give a reason. [2 marks]
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D Exam-style questions

D1 Two judges rank eight cakes in a competition. The table shows their ranks.

Cake	A	B	C	D	E	F	G	H
Judge 1	2	5	1	4	3	7	8	6
Judge 2	1	4	3	6	2	8	5	7

- (a) Work out Spearman's rank correlation coefficient. Give your answer to 3 decimal places. [3 marks]

Answer

- (b) Interpret this value in context. [1 mark]

- (c) A third judge ranks the same cakes. Spearman's rank correlation coefficient between Judge 1 and the third judge is 0.24. Which judge agrees more with Judge 1? Give a reason. [2 marks]

Total for D1: 6 marks

- D2** For 12 cars, Spearman's rank correlation coefficient between age and value is -0.88 . Kai says, "This shows weak correlation, because the value is negative." [2 marks]
- Is Kai correct? Give a reason for your answer.

- D3** Sara's hypothesis is: "Football clubs that spend more on players finish higher in the league." She ranks 10 clubs by spending (highest is 1) and by league position (top is 1). Spearman's rank correlation coefficient is 0.67. Does this support her hypothesis? Give a reason. [2 marks]

- D4** Ellie's hypothesis is: "Cyclists who train for more hours complete a race faster." The table shows data for six cyclists.

Cyclist	A	B	C	D	E	F
Training (hours per week)	3	8	5	10	6	2
Race time (minutes)	52	41	47	40	48	55

- (a) Work out Spearman's rank correlation coefficient. Give your answer to 2 decimal places. [3 marks]

Answer

(b) Does your answer support Ellie's hypothesis? Give a reason.

[2 marks]

Total for D4: 5 marks

E Extension

No route is given. The hints are at the end of the sheet. Use one at a time.

- E1** Two judges rank six paintings, A to F. Judge 1 ranks them 1, 2, 3, 4, 5, 6 in order. [4 marks]
Judge 2 gives A rank 1, C rank 6, D rank 4 and F rank 5, but the ranks for B and E are smudged. Spearman's rank correlation coefficient is 0.6. Work out the ranks Judge 2 gave to B and to E.

Answer

Extension hints

Cover these with paper. Uncover one at a time.

- E1** **Hint 1** Use the formula backwards to find $\sum d^2$.
Hint 2 $0.6 = 1 - \frac{6 \sum d^2}{210}$, so $\sum d^2 = 14$.
Hint 3 B and E must have ranks 2 and 3. Try both ways round and work out $\sum d^2$ each time.

How did it go?

Colour one circle on each line: not yet, nearly, yes.

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| I can rank data and work out r_s . | ☐ ☐ ☒ |
| I can interpret r_s in context. | ☐ ☐ ☒ |
| I can say when to use Spearman's rank. | ☐ ☐ ☒ |