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How to Compute Pearson's r (correlation Coefficient)

Steps

1. Compute the mean of X and Y
   $\bar{X}, \bar{Y}$

2. Calculation Deviation scores (x and y):
   subtract the mean from each value of X : $x = X - \bar{X}$
   subtract the mean from each value of Y : $y = Y - \bar{Y}$
   These deviation scores represent how far each value is from the mean

3. Create the product of Deviation scores (xy)
   Multiply corresponding deviation scores $x \times y$

4. Sum of xy, x^2 and y^2

5. Use pearson's r formula:

$$r = \frac{\Sigma (x \times y)}{\sqrt{\Sigma (x^2) \times \Sigma (y^2)}}$$

Lets calculate Pearson's correlation for the data in Table

X	Y	x(deviation)	y (deviation)	x^2	y^2	xy
1	4	-3	-5	9	25	15
3	6	-1	-3	1	9	3
5	10	1	1	1	1	1
5	12	1	3	1	9	3
6	13	2	4	4	16	8

9.42
4.92

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$x = (1+3+5+5+6)/5 = 4$ $\qquad y = (4+6+10+12+13)/5 = 9$

$$r = \frac{\Sigma xy}{\sqrt{\Sigma(x^2)\,\Sigma(y^2)}}$$

$$= \frac{30}{\sqrt{(16)\times(60)}} \simeq 0.968$$

What is the correlation between the two variables X and Y listed below?

SN	X	Y	x deviation	y deviation	xy	x^2	y^2
1	8	10	-1.42	0.08	-0.1136	2.0164	0.0064
2	10	9	0.58	-0.92	-0.5336	0.3364	0.8464
3	10	11	0.58	1.08	0.62464	0.3364	1.1664
4	11	11	1.58	1.08	1.7064	2.4964	1.1664
5	12	8	2.58	-1.92	-4.9536	6.6564	3.6864
6	12	10	2.58	0.08	0.2064	6.6564	0.0064
7	15	14	5.58	4.08	22.7664	31.1364	16.6464
8	5	8	-4.42	-1.92	8.4864	19.5364	3.6864
9	11	11	1.58	1.08	1.7064	2.4964	1.1664
10	9	9	-0.42	-0.92	0.3864	0.1764	0.8464
11	11	12	1.58	2.08	3.2864	2.4964	4.3264
12	10	13	0.58	3.08	1.7864	0.3364	9.4864
13	7	12	-2.42	2.08	-5.0336	5.8564	0.8464
14	8	7	-1.42	-2.92	4.1464	2.0164	8.5264
15	6	9	-3.42	-0.92	3.1464	11.6964	0.8464
16	15	12	5.58	2.08	11.6064	31.1364	4.3264
17	9	10	-0.42	0.08	-0.0336	0.1764	0.0064
18	10	12	2.58	1.08	2.7864	6.6564	1.1664
19	7	11	-2.42	1.08	-2.6136	5.8564	1.1664
20	8	5	-1.42	-4.92	6.9864	2.0164	24.2064
21	8	7	-1.42	-2.92	4.1464	2.0164	8.5264
22	8	10	-1.42	0.08	-0.1136	2.0164	0.0064
23	6	9	-3.42	-0.92	3.1464	11.6964	0.8464
24	10	9	0.58	-0.92	-0.5336	0.3364	0.846

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$$r = \frac{\Sigma xy}{\sqrt{\Sigma(x^2)\,\Sigma(y^2)}}$$
$$= 0.4868$$

∴ Computing the correlation of the variables $(r) = 0.48$

Introduction to Probability Standard

Probability is a branch of mathematics that deals with the likelihood of events occurring. It quantifies uncertainty ranging from 0 (impossible) to 1 (certain). Key concepts include experiments, outcomes, events, and probability rules. It is widely used in statistics, finance, science and every day decision making.

Summary of Probability Approaches

1. Symmetrical Outcomes:
   - Probability is based on equally likely outcomes
   - Example: A fair coin has a 50% chance of landing on heads or tails. A six sided die has a 1/6 chance for each number

2. Frequentist Approach
   - Probability is based on long term relative frequency
   - Example: If it rained 62% of the past 100,000 days in Seattle, the probability of rain tomorrow is estimated at 0.62. However, this approach becomes tricky when considering changing weather condition.

(3) Subjective Probability
Probability is based on personal belief or opinion
Example predicting an election outcome (eg Ms Garcia has a 70% chance of winning)" reflects opinion rather than an objective probability.

Basic Probability Concepts

1 Probability of a single Event
When all outcomes are equally likely, the probability of an event occuring is

$$\text{Probability} = \frac{\text{Number of favourable Outcomes}}{\text{Total Number of possible outcomes}}$$

Example : Rolling a die
- A six sided die has six posible outcomes i.e (1,2,3,4,5,6)
- Probability of rolling a 1 : 1/6
Probability of rolling a 1 or 6 : 2/6 = 1/3

2 Probability of Two independent Events Both Occuring
Example Rolling Two dice and getting a sum of 6
There are 36 possible outcomes when rolling two dice
Favorable outcomes for a sum of 6
(1,5), (2,4), (3,3), (4,2) (5,1) → 5 cases
Probability 5/36

3 Probability of an Event Not Occuring
- If P(A) is the probability of an event occuring, the probability of it is not occuring is
1 - P(A)

Example: Rolling two dice and Not getting a sum of 6
Probability of rolling a 6 : $\frac{5}{36}$

Probability of not rolling a 6 : $1 - 5/36$
$= \frac{31}{36}$

Probability of Independent Events

1 Definition of Independent Events

Two events, A and B are independent if the probab of B occurring remains the same regardless of whether A occurs.

* Example: Tossing a fair coin twice
  - Probability of heads on the second toss remains 1/2, whether the first toss was heads or tails.
  - Independent Events
    1 First toss is heads
    2 Second toss is heads

* Example of Non Independent Events
  - Rain in Houston vs Rain in Galveston
  - If it rains in Houston, it is more likely to rain in nearby Galveston

2 Probability of Both Events Occurring (A and B)

If A and B are independent, the probability of both occurring is

$$P(A \text{ and } B) = P(A) \times P(B)$$

Example Coin flip & Rolling a six sided die (Heads and getting 1

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P(heads) $(1/2)$ P(rolling a 1) $= 1/6$
P(heads and Rolling a 1) $= 1/2 \times 1/6$
$= 1/12$

3 Probability of Either Event Occuring (A or B)
For independent events, the probability that either A or B happens is
$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

Example: Rolling a die & Flipping a coin (rolling a 6 or Heads)
$P(6) = 1/6$ $\quad$ $P(\text{Heads}) = 1/2$ $\quad$ $P(6 \text{ and Heads}) = 1/12$
$P(6 \text{ or Heads}) = P(6) + P(\text{Heads}) - P(6 \text{ and Heads})$
$= 1/6 + \frac{1}{2} - 1/12$
$= 7/12$

4 Alternative Approach using "Not" Probability
Sometimes, it is easier to calculate the probability of an event not occuring and subtract from 1

Example: Rolling a die three times (at least one roll is a 1)
probability of not rolling a 1 in a single throw
$$P(\text{not } 1) \cdot 1 - \frac{1}{6} = \frac{5}{6}$$

probability of not rolling a 1 in three throws
$$\left(\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6}\right) = \frac{125}{216}$$

probability of at least one roll being a 1
$$1 - \frac{125}{216} = \frac{91}{216}$$