

Could statistical analysis have prevented the explosion of the space shuttle *Challenger*?

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The temperature at the time of launch was 29 degrees F.

Number of O-ring incidents during previous launches when temperature...

<u>above 65 degrees F</u>	<u>below 65 degrees F</u>
0 0 0 0 0	1 1 1 3
0 0 0 0 0	
0 0 0 0 0	
0 0 1 1 2	

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If the number of O-ring incidents is not associated with temperature, we might expect the 4 values for the cold launches to be like a random sample of 4 values from the 24 observed values.

The average number of failures for the cold launch data is 1.5. The average number of failures for the warm launch data is 0.2. What is the chance we would see a difference in averages as large as $1.5 - 0.2 = 1.3$, if there is no association between temperature and number of incidents?

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We will use a permutation test to test

H_0 : There is no association between temperature and number of O-ring incidents.

H_A : Cold temperature is associated with an increased number of O-ring incidents.

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The number of ways to pick 4 values from the 24 observed values is

$${}_{24}C_4 = \frac{24!}{20!4!} = \frac{(24)(23)(22)(21)}{(4)(3)(2)(1)}$$

$$= (23)(22)(21) = 10626$$

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The number of ways in which the average of the 4 values picked minus the average of the other 20 values is 1.3 or more is

<u>4 Values Picked</u>	<u>Difference in Averages</u>	<u>Number of Ways</u>
1 1 1 3	1.5-.2=1.3	${}_5C_3=10$
0 1 2 3	1.5-.2=1.3	$(17)(5)=85$
1 1 2 3	1.75-.15=1.6	${}_5C_2=10$
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Total		105

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Thus our one-sided p -value is $105/10626$ which is about 0.00988.

There is strong evidence that the number of O-ring incidents was associated with launch temperature in these 24 launches. It is highly unlikely that the observed difference between the two temperature groups is due to chance.

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