If a coin is fair, what is the probability of getting a result as unusual as 17 heads in 20 flips?

The answer to this question is the *p*-value for testing

H_0: Probability of Heads = 0.5

against

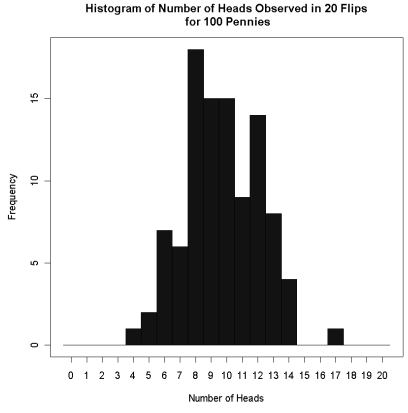
H_A: Probability of Heads $\neq$ 0.5

Sign Test

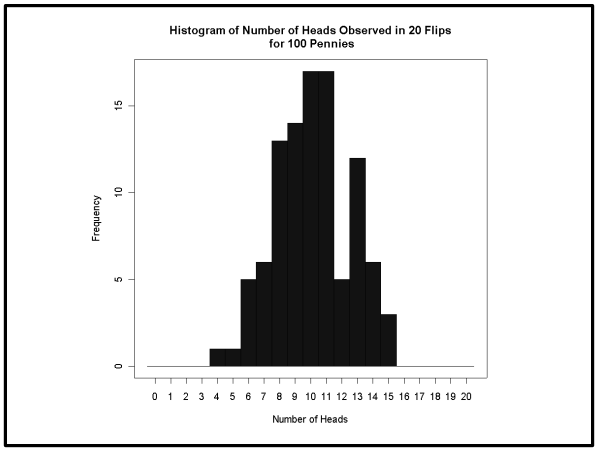
n=20
k=17

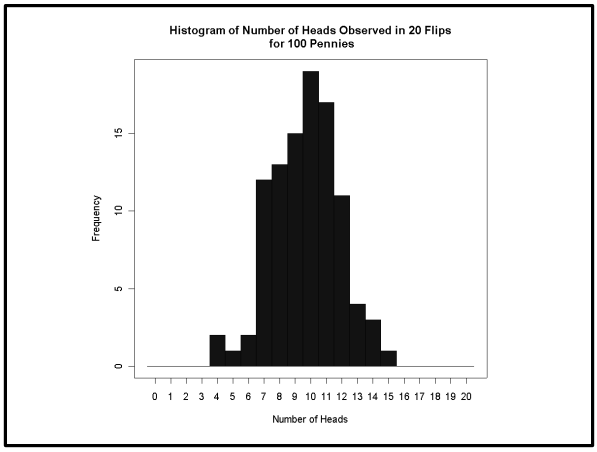
$$Z = \frac{k - n/2}{\sqrt{n/4}} = \frac{17 - 10}{\sqrt{5}} \sim 3.13$$

The approximate two-sided *p*-value is about 0.0017. The exact two-sided *p*-value is about 0.0026.



If 100 coins are all fair, what is the probability that one or more of them will exhibit a result as unusual as 17 heads in 20 flips?


Histogram of Number of Heads Observed in 20 Flips
for 100 Pennies
Frequency
0
5
10
15
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Number of Heads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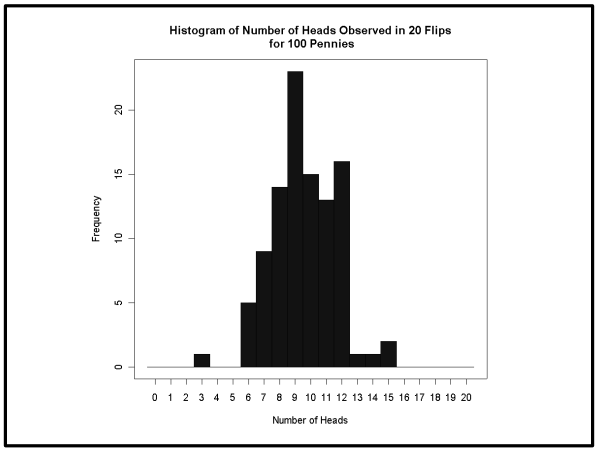
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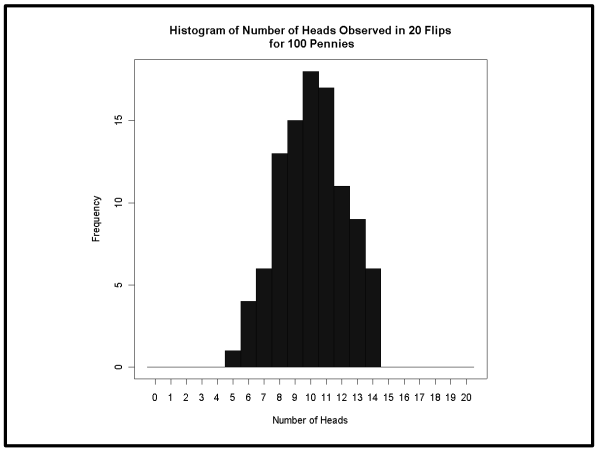
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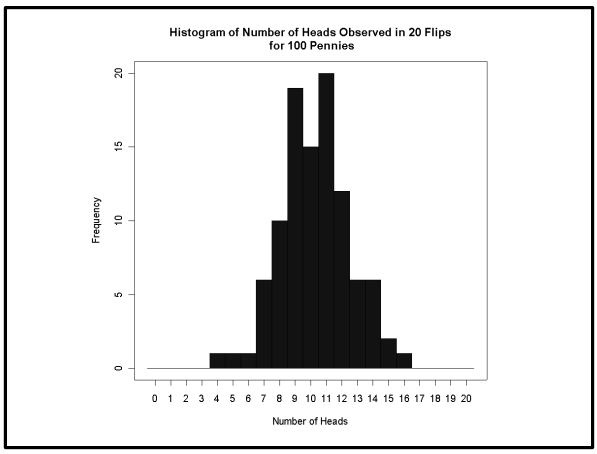
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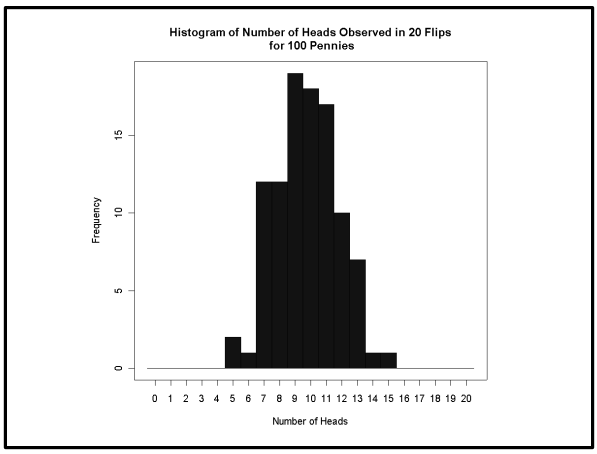
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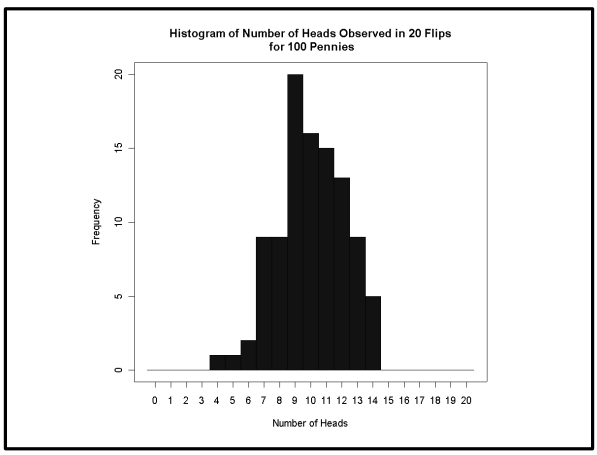
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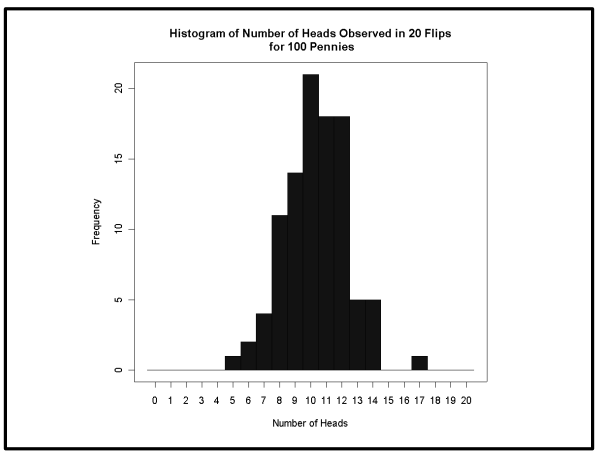
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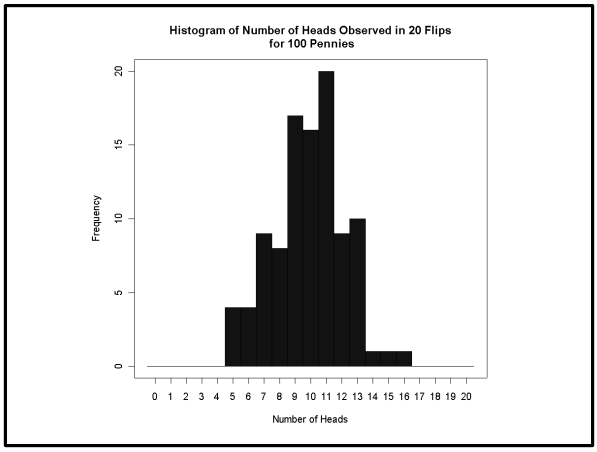

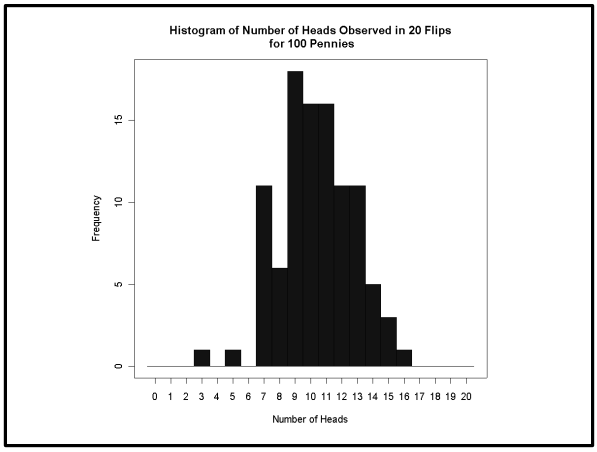

The probability of obtaining 0, 1, 2, 3, 17, 18, 19, or 20 heads when flipping a fair coin 20 times is about 0.0026.

If 100 coins are each flipped 20 times, the chance that one or more of them will show 0, 1, 2, 3, 17, 18, 19, or 20 heads is about 0.227.

Do we have convincing evidence that Jason's penny is not fair?

No. The results that we saw were consistent with the results that we would expect to get when flipping 100 fair coins 20 times each.