

Left-tailed test: P -value is the probability of x or fewer successes among n trials.

Right-tailed test: P -value is the probability of x or more successes among n trials.

Two-tailed test: The two-tailed test can be treated with different approaches, some of which are quite complex. For example, Minitab uses a “likelihood ratio test” that is different from the following relatively simple approach:

If $\hat{p} > p$, the P -value is twice the probability of x or more successes.

If $\hat{p} < p$, the P -value is twice the probability of x or fewer successes.

Example 4 Using the Exact Method

In testing a method of gender selection, 10 randomly selected couples are treated with the method, they each have a baby, and 9 of the babies are girls. Use a 0.05 significance level to test the claim that with this method, the probability of a baby being a girl is greater than 0.75.

Solution

Requirement check The normal approximation method described in Part 1 of this section requires that $np \geq 5$ and $nq \geq 5$, but $nq = (10)(0.25) = 2.5$, so the requirement is violated. The exact method has only the first two requirements listed near the beginning of this section, and those two requirements are satisfied. Here are the null and alternative hypotheses:

$$H_0: p = 0.75 \quad (\text{null hypothesis})$$

$$H_1: p > 0.75 \quad (\text{alternative hypothesis and original claim})$$

Instead of using the normal distribution, we use technology to find probabilities in a binomial distribution with $p = 0.75$. Because this is a right-tailed test, the P -value is the probability of 9 or more successes among 10 trials, assuming that $p = 0.75$. See the accompanying STATDISK display of exact probabilities from the binomial distribution. This STATDISK display shows that the probability of 9 or more successes is 0.2440252 when rounded to seven decimal places, so the P -value is 0.2440252. The P -value is high (greater than 0.05), so we fail to reject the null hypothesis. There is not sufficient evidence to support the claim that with the gender selection method, the probability of a girl is greater than 0.75.

STATDISK

Num Trials, n:

10

Evaluate

Success Prob, p:

0.75

Mean:

7.5000

St Dev:

1.3693

Variance:

1.8750

x	P(x)	P(x or fewer)	P(x or greater)
0	0.0000010	0.0000010	1.0000000
1	0.0000286	0.0000296	0.9999990
2	0.0003862	0.0004158	0.9999704
3	0.0030899	0.0035057	0.9995842
4	0.0162220	0.0197277	0.9964943
5	0.0583992	0.0781269	0.9802723
6	0.1459980	0.2241249	0.9218731
7	0.2502823	0.4744072	0.7758751
8	0.2815676	0.7559748	0.5255928
9	0.1877117	0.9436865	0.2440252
10	0.0563135	1.0000000	0.0563135