ORIGIN ≡ 0

Sign Test

The Sign Test is a nonparametric analog to the paired t-test. It requires the use of ordinal data - data that can be ordered but need not have specific numerical values. Of course, ordinal data can be constructed from cardinal data (ratio or interval scale data, i.e., metric data to which standard arithmetic and measuring distances apply). This test is typically employed when paired data seriously violates the underlying assumption of normality for the paired t-test. However, choice of the sign test involves loss of information and, as a result, lessens power.

The Sign Test is a special case of the more general Binomial Test of Population Proportions.

0	hindleg	foreleg	difference
1	142	138	plus
2	140	136	plus
3	144	147	minus
4	144	139	plus
5	142	143	minus
6	146	141	plus
7	149	143	plus
8	150	145	plus
9	142	136	plus
10	148	146	plus

< Zar Example 24.10

n := 10

Assumptions:

- **Observed values $X_{1,1}$, $X_{1,2}$, $X_{1,3}$, ... $X_{1,n}$ are a random sample exactly matched with Observed values $X_{2,1}$, $X_{2,2}$, $X_{2,3}$, ... $X_{2,n}$ across individuals 1,2,3, ... ,n.**
- **Let the value $d_i = X_{1,i} - X_{2,i}$ for each individual i be assessed as d_i = positive or negative single observations or discrete classes of observations with observed frequency.**
- **The d_i's are independent.**
- **The underlying distribution of the d_i's is continuous & symmetric but not necessarily a Normal Distribution.**
- **All d_i's have the same median**

Hypotheses:

H_0: $\Delta = 0$ **< No population ordinal difference in median**

H_1: $\Delta \neq 0$ **< Two sided test**

Exact Method Test Statistic:

C := 8 **C = number of d_i's where d_i is +**

Probability Value:

IF C > n/2

$$P := 2 \cdot \sum_{k=C}^{n} \text{combin}(n,k) \cdot \left(\frac{1}{2}\right)^n \qquad P = 0.1094$$

IF C < n/2

$$P := 2 \cdot \sum_{k=0}^{C} \text{combin}(n,k) \cdot \left(\frac{1}{2}\right)^n \qquad P = 1.9785$$

Alternate Calculation using the Binomial function pbinom():

$p := 0.5$ **< set at 1/2**

$P := 2 \cdot \text{pbinom}(n - C, n, p)$ $P = 0.1094$ **for C > n/2**

$P := 2 \cdot \text{pbinom}(C, n, p)$ $P = 1.9785$ **for C < n/2**

Prototype in R:

```
#SIGN TEST FOR PAIRED DATA
#PAIRED t-TEST ANALOG

ZAR=read.table("c:/DATA/Biostatistics/ZarEX24.10.txt")
ZAR
attach(ZAR)
n=length(hindleg)
n
p=0.5
PLUS=length(hindleg[difference=="plus"])
PLUS
MINUS=length(hindleg[difference=="minus"])
MINUS

binom.test(PLUS,n,p, alternative="two.sided",conf.level=0.95)
```

```
        Exact binomial test

data:  PLUS and n
number of successes = 8, number of trials = 10, p-value = 0.1094
alternative hypothesis: true probability of success is not equal to 0.5
95 percent confidence interval:
 0.4439045 0.9747893
sample estimates:
probability of success
                   0.8
```

^ **Note: the confidence interval R reports is the Clopper-Pearson Inverval around parameter p.**
This is not relevant to the Sign Test and is not prototyped here.