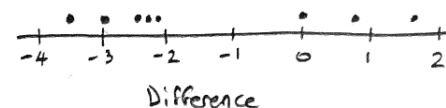


# CIMT Further Statistics - p80 Example for Wilcoxon Signed Rank Test

Justification: paired data  
no assumptions about parent distribution type

Draw dot plot of data to inform the analysis

plausible symmetrical distribution.



$H_0$ : population median difference = 0 where difference = A - B.  
 $H_1$ : population median difference < 0 (i.e. B gives higher scores)

Assume  $H_0$  to be true  
 $\alpha = 5\%$ , 1 tail test

Subject

|          |      |      |      |      |      |      |      |      |
|----------|------|------|------|------|------|------|------|------|
| method A | 11.2 | 8.6  | 6.5  | 17.3 | 14.3 | 10.7 | 9.8  | 13.3 |
| method B | 10.4 | 12.1 | 9.1  | 15.6 | 16.7 | 10.7 | 12.8 | 15.5 |
| A - B    | 0.8  | -3.5 | -2.6 | 1.7  | -2.4 | 0    | -3   | -2.2 |
| A - B    | 0.8  | 3.5  | 2.6  | 1.7  | 2.4  | 0    | 3    | 2.2  |
| rank     | 1    | 7    | 5    | 2    | 4    |      | 6    | 3    |

now  $W_+ = 1 + 2 = 3$   
 $W_- = 7 + 5 + 4 + 6 + 3 = 25$  } sum to 28 =  $\frac{1}{2} \times 7 \times 8$  ✓ check

$W = \min(W_-, W_+) = 3$

smallest value of  $W = 0$   
largest value of  $W = 28$



now, under  $H_0$ , each rank is equally likely to be +ve or -ve  
we also have  $n = 7$  ranks, so there are  $2^7$  combinations  
with 7 nos. what are all the rank sums we can get?

| rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------|---|---|---|---|---|---|---|
| sum  | 0 |   |   |   |   |   |   |
| 1    | ✓ |   |   |   |   |   |   |
| 2    |   | ✓ |   |   |   |   |   |
| 3    | ✓ | ✓ |   |   |   |   |   |
| 3    |   |   | ✓ |   |   |   |   |
| 4    | ✓ |   | ✓ |   |   |   |   |
| 4    |   |   |   | ✓ |   |   |   |
| 5    |   |   |   |   | ✓ |   |   |
| 5    | ✓ |   |   | ✓ |   |   |   |
| 5    |   | ✓ | ✓ |   |   |   |   |
| 6    |   |   |   |   |   | ✓ |   |
| 6    | ✓ |   |   |   | ✓ |   |   |
| 6    |   | ✓ |   | ✓ |   |   |   |
| 6    | ✓ | ✓ | ✓ |   |   |   |   |

1 way to get 0

1 way to get 1

1 way to get 2

2 ways to get 3

2 ways to get 4

3 ways to get 5

4 ways to get 6

so  $P(W \leq 3) = \frac{5}{2^7} = 0.039063$

At 5% level, this is inside the 5% tail so we have evidence to reject  $H_0$  and conclude that the median difference is less than zero (i.e. method B gives higher scores)