

# Outline

- Why Nonparametrics
- The Sign Test
- The Wilcoxon Signed Rank Test
- The Wilcoxon Rank Sum Test

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# Why Nonparametrics

- **Small sample size**
  - Possibly unavoidable
  - Central Limit not applicable
- **Data may be not strictly continuous**
  - Ratings (pain rating index)
  - Rankings (completely disagree < --- > completely agree)
- **Notable departure from normality**
  - Presence of extreme values
  - Transformed data (proportion of calories from fat)

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# The Sign Test

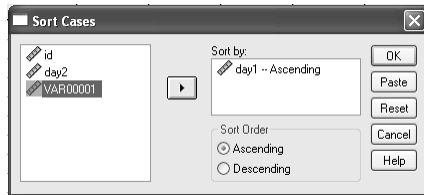
- P-values can be determined exactly by the binomial distribution, or approximated by the normal approximation to the binomial
- Example 9.1 (p. 250)
  - Pre-post tests data tend to show regression to the mean
    - High score in one test usually leads to low score in the other
    - Low score in *pre* usually yields higher score on *post*.
  - Data: caloric intake of 33 boys at two days
  - Averages of 7 most extreme at day 1 tend to follow regression to the mean
  - No regression to the mean implies same proportion moving in each direction

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- Thus  $H_0 : \pi = 0.5$  vs.  $H_a : \pi > 0.5$
- TIES ARE DISCARDED FROM ANALYSIS
- A large number of ties denies regression to the mean (reduced sample size, detrimental to power)
- N=14 pairs
- Test statistic: Number of cases with extreme day1 moving toward the mean at day2 → 10
- Conducting test at 0.05 level using Tables from Binomial distribution yields a rejection region of 11 thru 14
- Observed statistic (10) is not in the rejection region, p-value=0.0898
- Power of test for  $\pi = 0.7$  equals 0.3552 use Table B2 with  $n = 14, \pi = 0.3, x = 3, 2, 1, 0$      $n = 14, \pi = 0.7, x = 11, 12, 13, 14$

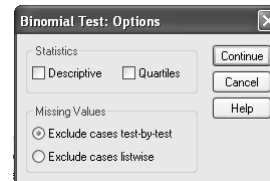
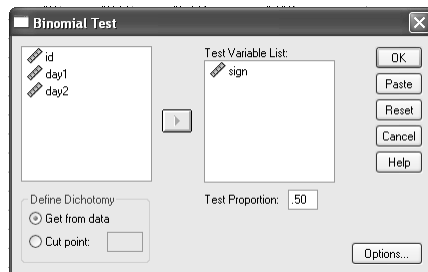
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- Sort data “day1” ascending
  - “OK”
- For 7 smallest/largest values at “day1” Type in 1/0 according to regression to the mean (for ID=13 day1=1053 and day2=2484 INCREASES thus value=1; for ID=50 value=0)



	id	day1	day2	VAR000001	var	var
1	13	1053	2484	1.00		
2	50	1292	810	.00		
3	33	1505	1925	1.00		
4	149	1645	2369	1.00		
5	150	1723	3163	1.00		
6	16	1753	1054	.00		
7	118	1781	1844	1.00		
8	10	1823	1623	.		
9	44	1843	2907	.		
10	141	1898	1236	.		
11	107	2000	1797	.		
12	11	2007	1748	.		
13	148	2011	1566	.		
14	105	2039	1905	.		
15	32	2074	3312	.		
16	46	2301	4120	.		
17	137	2310	1569	.		
18	39	2330	2339	.		
19	26	2340	3182	.		
20	127	2348	2122	.		

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- Analyze; Nonparametric Tests; Binomial
- Select “sign” into “Test Variable List” box
- Dichotomy: “get from data” (already calculated)
- Options: Basic statistics; Missing values (use default)
- Type in “Test Proportion): 0.5 for Sign test
- Ok

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**Binomial Test**

	Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
VAR00001	Group 1	10	.71	.50	.180
	Group 2	4	.29		
	Total	14	1.00		

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- **Example 9.2 (p. 252)**

- Interlaboratory testing
  - Proper calibration of instruments (validity/bias)
  - Proper training of technicians (reliability/precision)
- Data: 100 labs measure lead in single blood sample
  - known concentration 41 microg/dL
  - Average reported from all labs 44 microg/dL
  - Large variability: range 30-60 microg/dL
- Bias between labs can be assessed with the sign test using the true known concentration
- Bias of one lab data may be ascertained with several measurements from same lab
  - See data on page 252
- Proper calibration would yield half of measurements below and above true of 41

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- Thus  $H_0 : \pi = 0.5$  vs.  $H_a : \pi \neq 0.5$
- One TIE DISCARDED FROM ANALYSIS
- N=12 pairs
- Test statistic: Number of cases above 41
- Conducting test at 0.05 level using Tables from Binomial distribution yields a rejection region of thru or thru
- Observed statistic (8) is not in the rejection region, p-value=0.39
- There is no evidence that measurements in this lab are different from the true

Binomial Test

	Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
VAR00003	Group 1	8	.67	.50	.388
	Group 2	4	.33		
	Total	12	1.00		

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	VAR00001	VAR00002	VAR00003	var	var	var
1	1.00	45.00	1.00			
2	2.00	43.00	1.00			
3	3.00	40.00	.00			
4	4.00	44.00	1.00			
5	5.00	49.00	1.00			
6	6.00	36.00	.00			
7	7.00	51.00	1.00			
8	8.00	46.00	1.00			
9	9.00	35.00	.00			
10	10.00	50.00	1.00			
11	11.00	41.00	.			
12	12.00	38.00	.00			
13	13.00	47.00	1.00			
14						

- A t-test makes better use of data: 42 is same as 51
- Other nonparametric tests use more information in data
- Sign test easy to carry out
- Can be used with nonnumerical data

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