L'importanza di essere significante: Un esempio basato sul test della Torre di Londra

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Università di Padova

La psicometria tra oggi e domani:
Sfide e nuovi orizzonti

20 Giugno 2023

The ratio between the measures of a and b is constant and independent of the measurement unit:

$$\frac{\varphi(a)}{\varphi(b)} = \frac{\varphi'(a)}{\varphi'(b)},$$

where φ and φ' are two different scales of measurement of the same variable.

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Meaningful comparisons

The comparison between a and b is meaningful if it is invariant under all the unit transformations.

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Beyond meaningful comparison

Given that there is a difference between a and b, is this difference significant (or not) regardless of the scales of measurement?

$\varphi(P) = [0, 1, 2, 3]$ $\varphi'(P) = [0, 2, 4, 10]$

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				φ					
	it01	it02	it03	it04	it05	it06	it07	it08	it09
Joe	0	1	2	2	2	3	3	3	3
Jane	0	2	2	2	3	3	3	3	3
Max	0	1	0	2	3	3	3	3	3
				φ'					
Joe	0	2	4	4	4	10	10	10	10
Jane	0	4	4	4	10	10	10	10	10
Max	0	2	0	4	10	10	10	10	10

$\varphi(P) = [0, 1, 2, 3]$ $\varphi'(P) = [0, 2, 4, 10]$ $\varepsilon(P) = [0, 2, 3]$

	it01	it02	it03	φ it04	it05	it06	it07	it08	it09
Joe	0	1	2	2	2	3	3	3	3
Jane	0	2	2	2	3	3	3	3	3
Max	0	1	0	2	3	3	3	3	3
				φ'					
Joe	0	2	4	4	4	10	10	10	10
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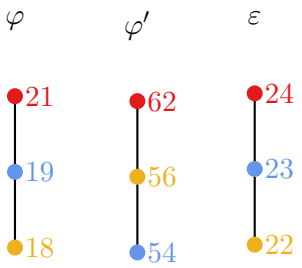
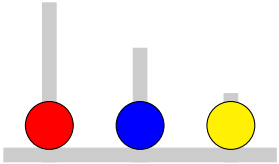
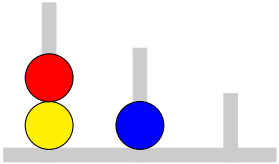
	it01	it02	it03	it04	it05	it06	it07	it08	it09
				φ					
Joe	0	1	2	2	2	3	3	3	3
Jane	0	2	2	2	3	3	3	3	3
Max	0	1	0	2	3	3	3	3	3
				φ'					
Joe	0	2	4	4	4	10	10	10	10
Jane	0	4	4	4	10	10	10	10	10
Max	0	2	0	4	10	10	10	10	10
				ϵ					
Joe	0	2	2	2	2	3	3	3	3
Jane	0	2	2	2	3	3	3	3	3
Max	0	2	0	2	3	3	3	3	3





Starting configuration

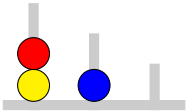


Goal configuration

Problem complexity influenced by:

- Number of moves
- Number of alternative paths
- Hierarchy of the starting/goal configuration

- 12 problems
- Same starting configuration
- More than one attempt per item



Problem	Minimum moves	Alternative paths
Example	2	1
1	2	1
2	2	1
3	3	2
4	3	1
5	4	2
6	4	1
7	4	1
8	4	1
9	5	2
10	5	1
11	5	1
12	5	2

Scoring system	First attempt	Second attempt	Third attempt	Fourth on	Total sum score
KR	3	2	1	0	0 – 36
SH1	1	0			0 – 12

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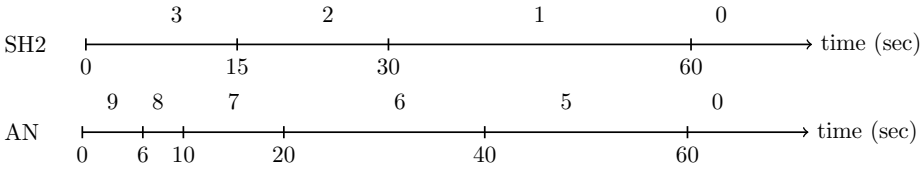
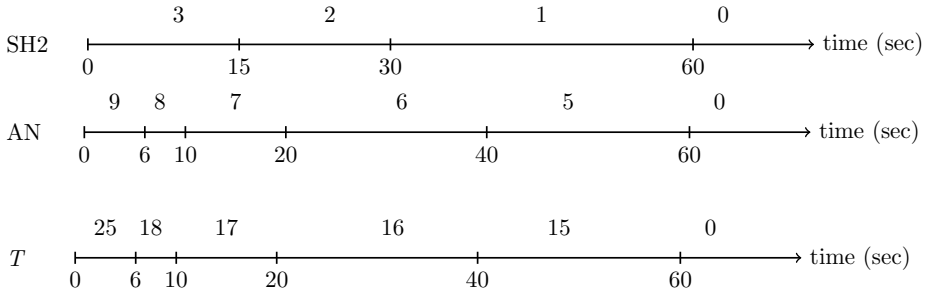
Scoring system	First attempt	Second attempt	Third attempt	Fourth on	Total sum score
P1	3	2		0	0 – 36
P1′	3	1		0	0 – 36

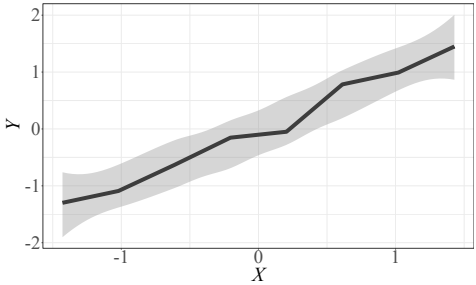
Scoring system	First attempt	Second attempt	Third attempt	Fourth on	Total sum score
KR	3	2	1	0	0 – 36
SH1	1	0			0 – 12

Scoring system	First attempt	Second attempt	Third attempt	Fourth on	Total sum score
P1	3	**2**		0	0 – 36
P1′	3	**1**		0	0 – 36


3
2
1
0
SH2
time (sec)
0
15
30
60
9
8
7
6
5
0
AN
time (sec)
0
6
10
20
40
60


3
2
1
0
SH2
time (sec)
0
15
30
60
9
8
7
6
5
0
AN
time (sec)
0
6
10
20
40
60
25
18
17
16
15
0
T
time (sec)
0
6
10
20
40
60

Monotonic relation



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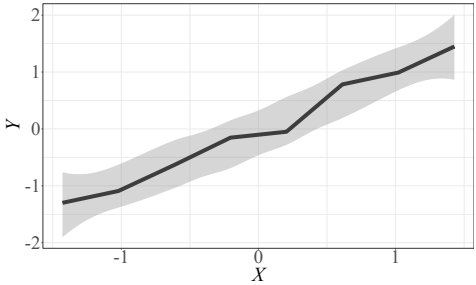
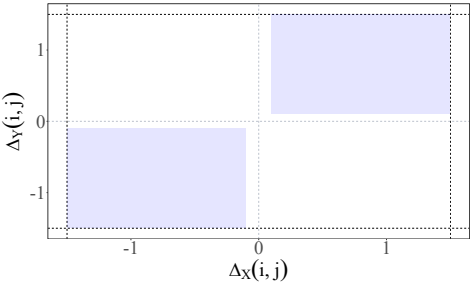


Distances and inversions



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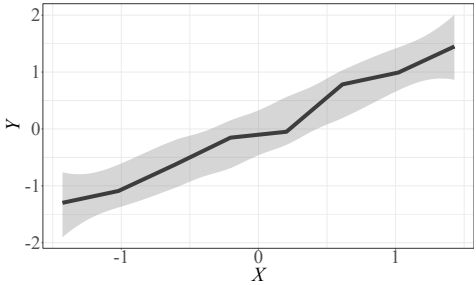
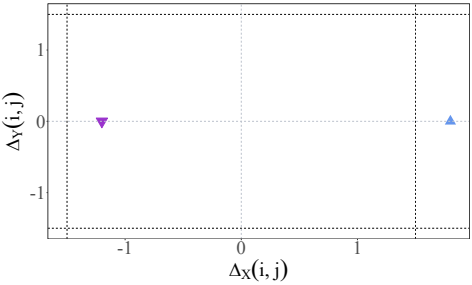
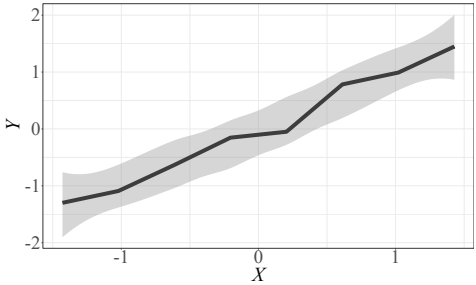


Distances and inversions



Monotonic relation



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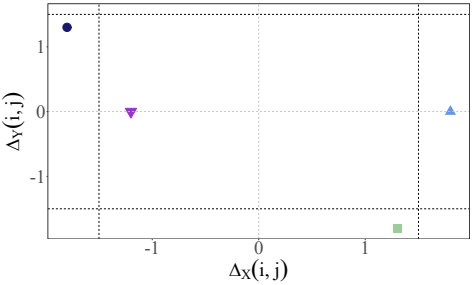


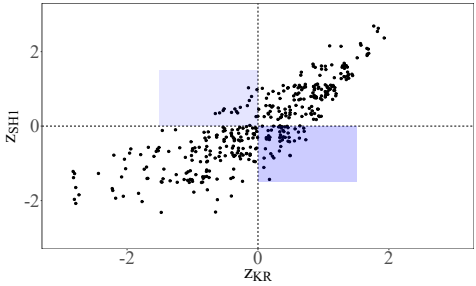
H_0: $\mu_{g1} - \mu_{g2} = 0$

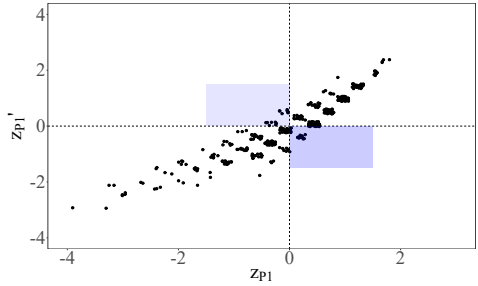
H_1: $\mu_{g1} - \mu_{g2} \neq 0$

t-test on the standardized scores considering different grouping variables:

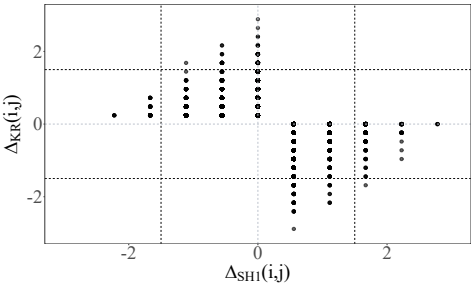
Grouping variable	n_1	n_2
Gender	199	196
Administration order	202	193
Administration modality	211	184
Schooling years	171	224

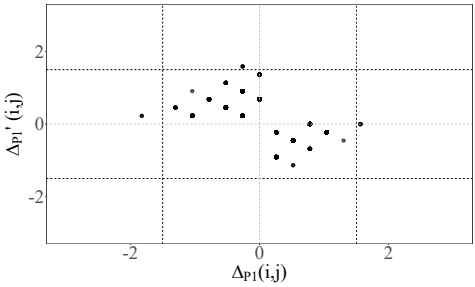
Attempt-based SM: Monotonic relation





Attempt-based SM: Differences and distances





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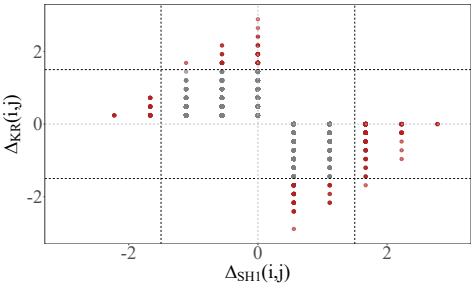
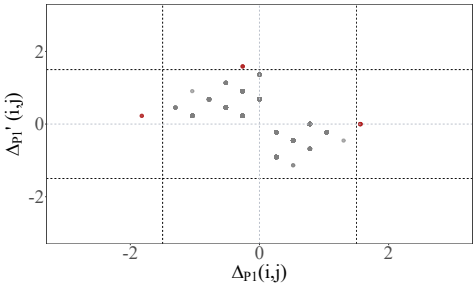
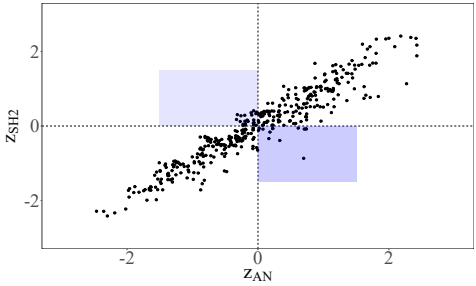
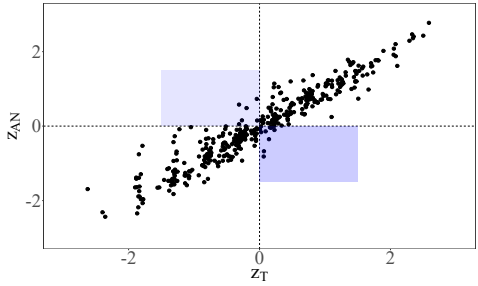




Latency-based SM: Monotonic relation





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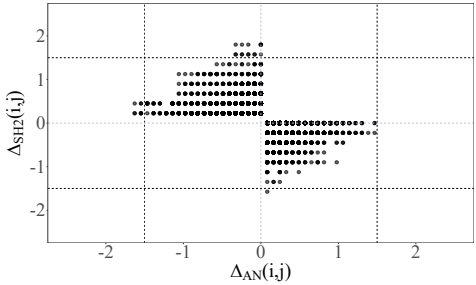

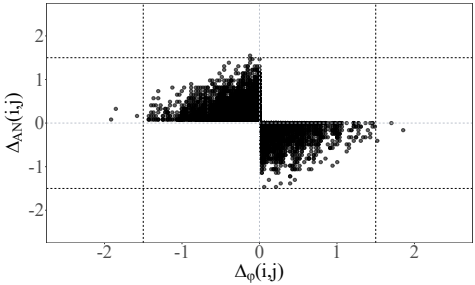

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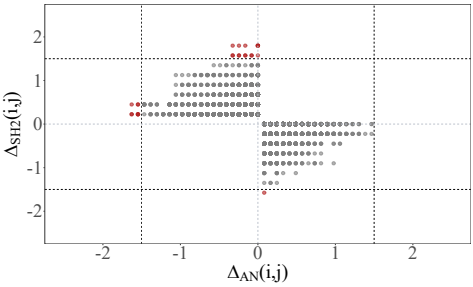

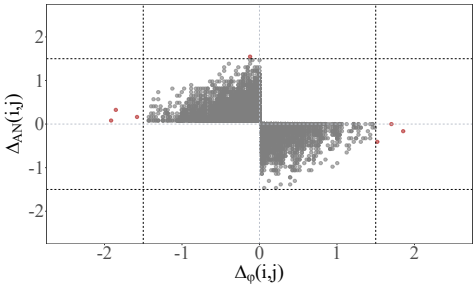

Attempt-based SM

	KR	SH1	P1	P1'
	d	*d*	*d*	*d*
Gender	1.84	2.11*	1.69	2.03*
	0.19	0.21	0.17	0.20
Test order	−0.15	0.80	−0.48	0.28
	−0.01	0.08	−0.05	0.03
Adm. Modality	−2.85**	−1.93	−2.69**	−2.35*
	−0.29	−0.19	−0.27	−0.24
Schooling	3.95***	3.56***	3.82***	3.85***
	0.39	0.36	0.38	0.39

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Latency-based SM

	SH2	AN	T
	d	*d*	*d*
Gender	1.64	1.88	2.10*
	0.17	0.19	0.21
Test order	0.37	0.99	0.95
	0.04	0.10	0.10
Adm. Order	−2.90**	−2.33*	−2.84**
	−0.29	−0.23	−0.29
Schooling	5.52***	5.32***	5.13***
	0.56	0.54	0.52

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	d	*d*	*d*
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Are we sure sum scores are a good idea...?

PSYCHOMETRIKA—VOL. 89, NO. 1, 84–117
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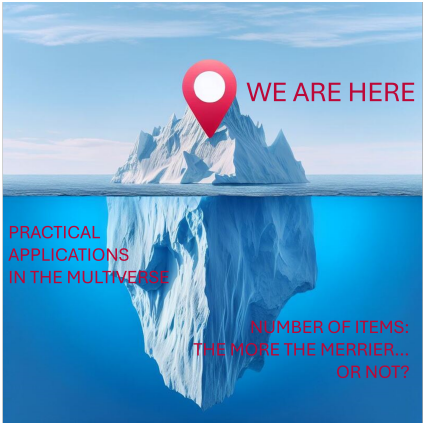
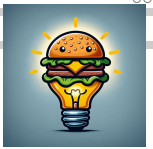
Sum scores of ordinal data bring to a multiverse of contrasting results


WE ARE HERE
PRACTICAL
APPLICATIONS
IN THE MULTIVERSE
NUMBER OF ITEMS:
THE MORE THE MERRIER...
OR NOT?

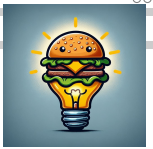


Sum scores of ordinal data bring to a multiverse of contrasting results

Increasing the number of items does not solve the issue.... it worsens it!

Meaningfulness of psychological measures and reproducibility are interlaced

Research founded by the project “Computerized, Adaptive and Personalized Assessment of Executive Functions and Fluid Intelligence” (PRIN 2020, Prot. 20209WKCLL, P.I. Prof. Luca Stefanutti)



Sum scores of ordinal data bring to a multiverse of contrasting results

Increasing the number of items does not solve the issue.... it worsens it!

Meaningfulness of psychological measures and reproducibility are interlaced

Bright side:

Sum scores of truly dichotomous data (i.e., true vs. false, correct vs. incorrect) are meaningful

Research founded by the project “Computerized, Adaptive and Personalized Assessment of Executive Functions and Fluid Intelligence” (PRIN 2020, Prot. 20209WKCLL, P.I. Prof. Luca Stefanutti)