matRiks: An R package for the automatic generation of Raven-like matrices

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AIP-Sezione Sperimentale Conference 2023
Symposium: New frontiers for the adaptive assessment of executive functions

18th September 2023

Assessment of fluid intelligence or abstract reasoning

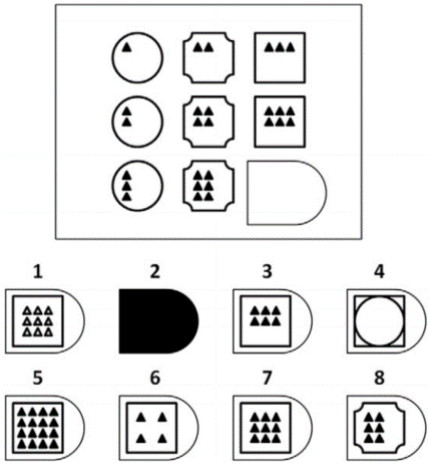
Beyond clinical assessment $\rightarrow$ Job recruitment

Assessment of fluid intelligence or abstract reasoning

Beyond clinical assessment $\rightarrow$ Job recruitment

Only once in a lifetime (or after a very looooooong time)

An example



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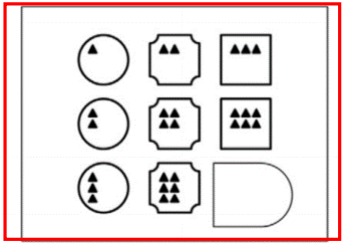

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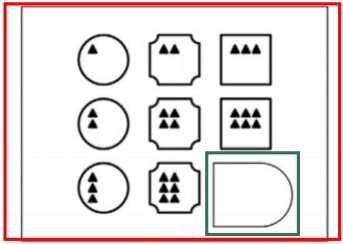

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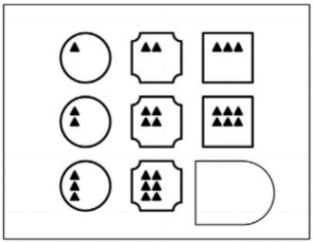
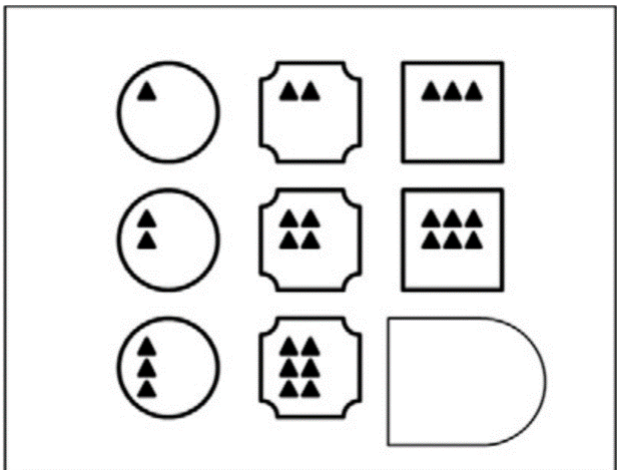


An example: The matrix



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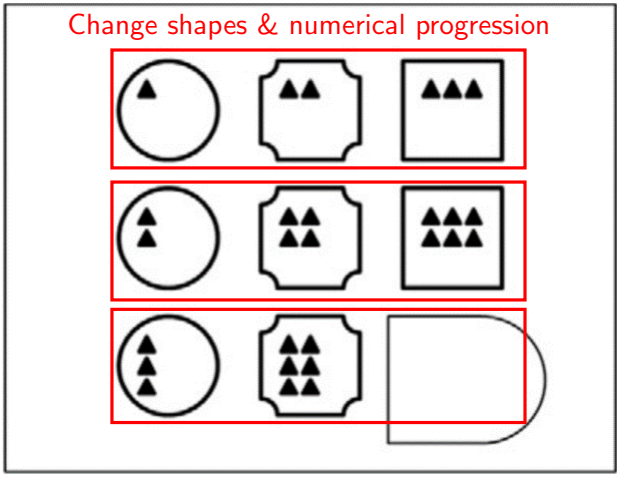

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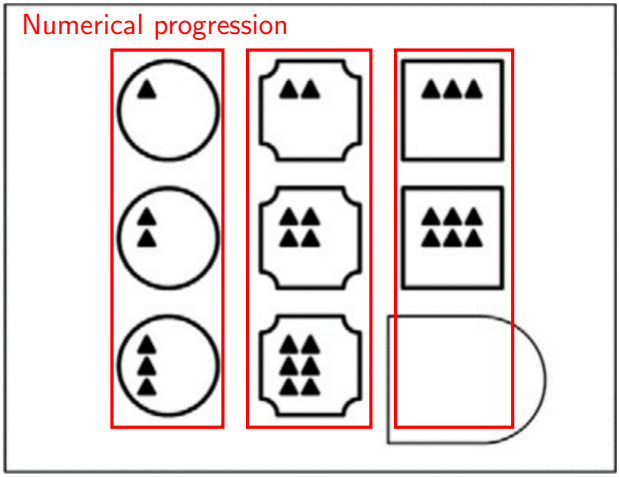
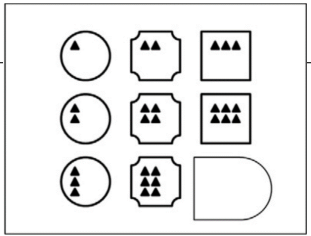
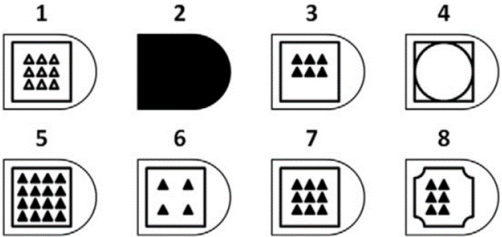


An example: The response list





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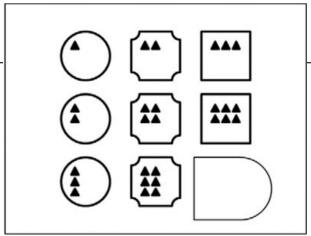

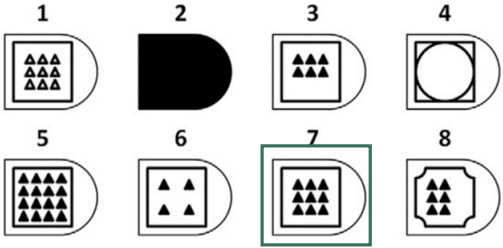

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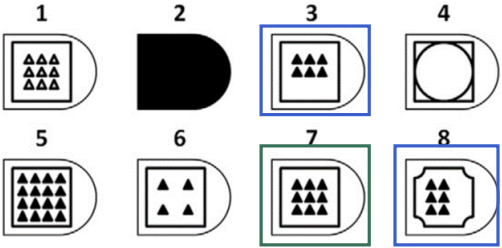
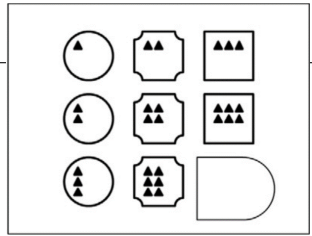
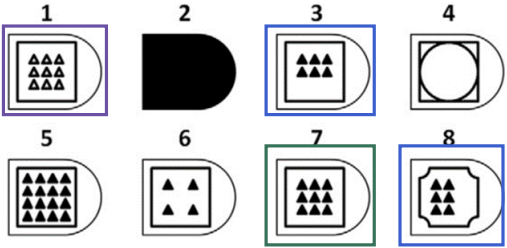
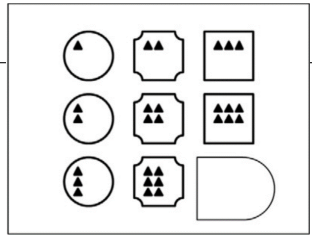




Repetition	Repetition of a cell adjacent to the blank space
Incomplete Correlate	Almost the correct response
Wrong Principle	Copy of a non adjacent cell or combination of cells
Difference	Different in appearance from every element of the matrix

An example: The response list





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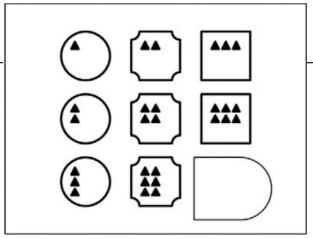

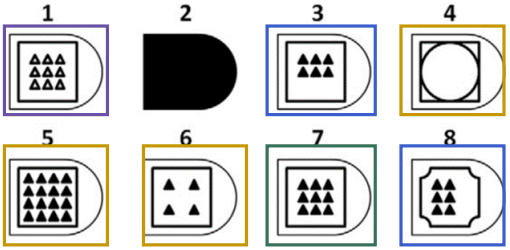

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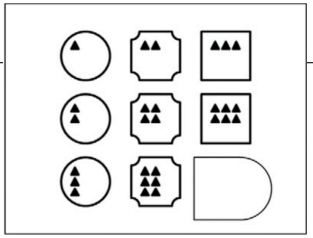

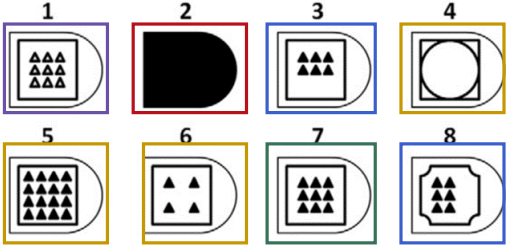

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Category	Rule name	Definition
Visuospatial	Object addition	Visually merge two objects
	Movement	Change the position of an object across the cells
	Rotation	Change the spatial orientation of the objects across the cells
	Mental transformation	Apply the characteristics of the objects in the second cell to the objects in the first cell to obtain the object in the third cell.
	Numerical progression	Quantitative increase or decrease in the number of objects from cell to cell
	Changes in shape	Change objects across cells
	Changes in shade	Change the shade of the objects across cells
	Changes in size	Change the size of the objects across cells
	Changes in outline	Change the outline of the objects across cells
Logical	AND	The third cell contains only the elements that appeared in both the first and second cells ($\cap$)
	OR	The third cell contains all the elements in the first and second cells ($\cup$)
	XOR	The third cell contains the elements in the first cell not present in the second cell and vice-versa (Δ)
Directional Logic	Horizontal	The objects are modified across columns
	Vertical	The objects are modified across rows
	Diagonal	The objects are modified horizontally and diagonally

```
devtools::install_github("https://github.com/OttaviaE/matRiks")
```

- Generates 2×2 or 3×3 Raven-like matrices
- Generates the response list associated with the matrix (1 correct response + 10 distractors)
- Core elements:

  Objects *Rules* *Matrix generator* *Response options generator*

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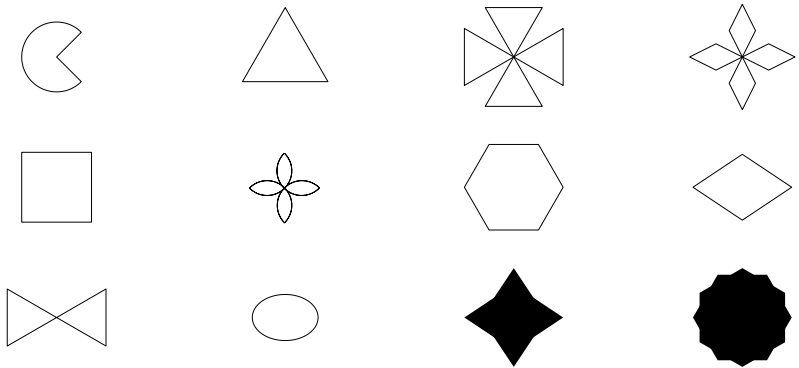
Objects *Rules* *Matrix generator* *Response options generator*

(Some) of the available objects



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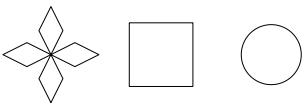
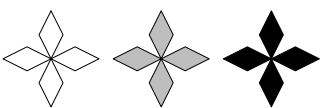
Visuospatial rules

Rotate

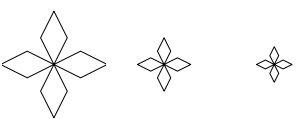
Shape



Shade



Size

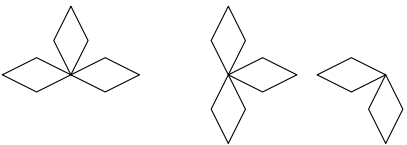


Logical rules

AND ($\cap$)

OR ($\cup$)

XOR (Δ)



Matriks generator

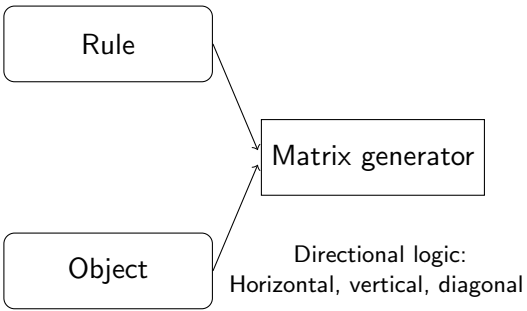
Rule

Matriks generator

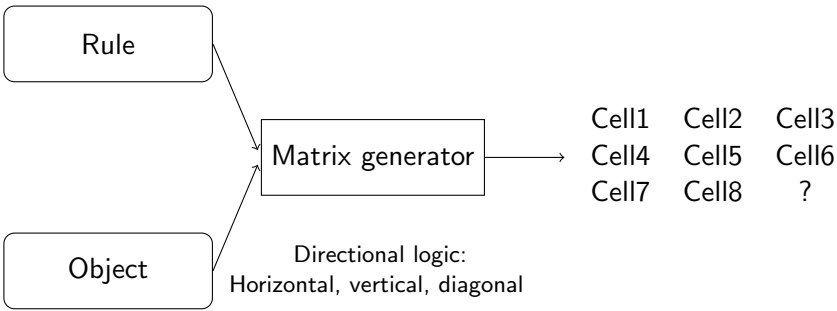
Rule

Object

Matriks generator

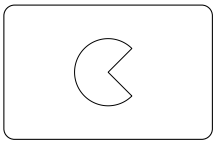


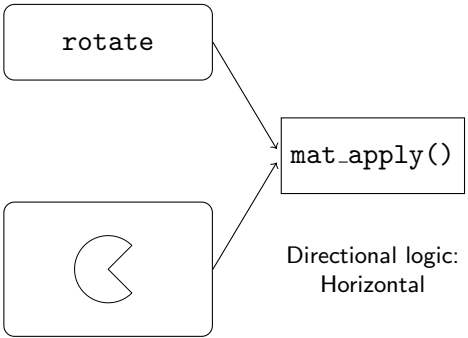
Matriks generator



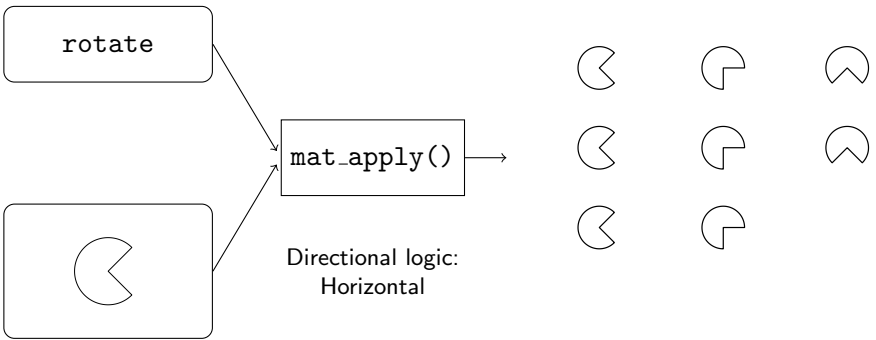
`rotate`

rotate





Directional logic:
Horizontal


rotate
mat_apply()
Directional logic:
Horizontal

Response options generator

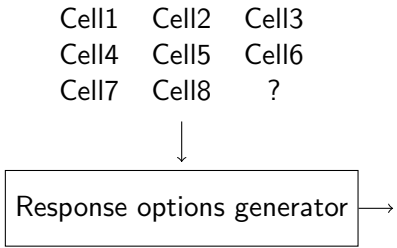
Cell1	Cell2	Cell3
Cell4	Cell5	Cell6
Cell7	Cell8	?

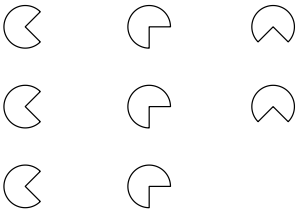
Response options generator

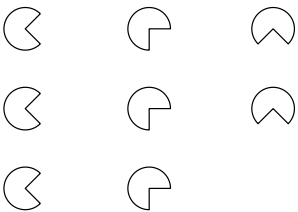
Cell1	Cell2	Cell3
Cell4	Cell5	Cell6
Cell7	Cell8	?

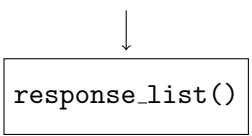
Response options generator

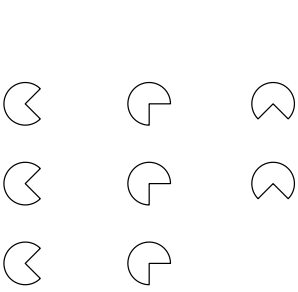
Response options generator



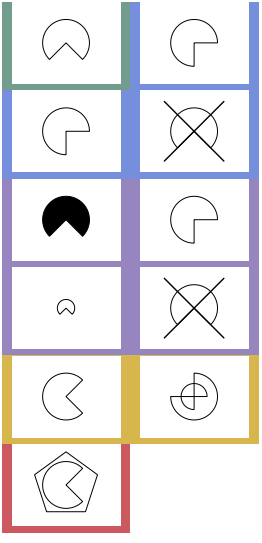




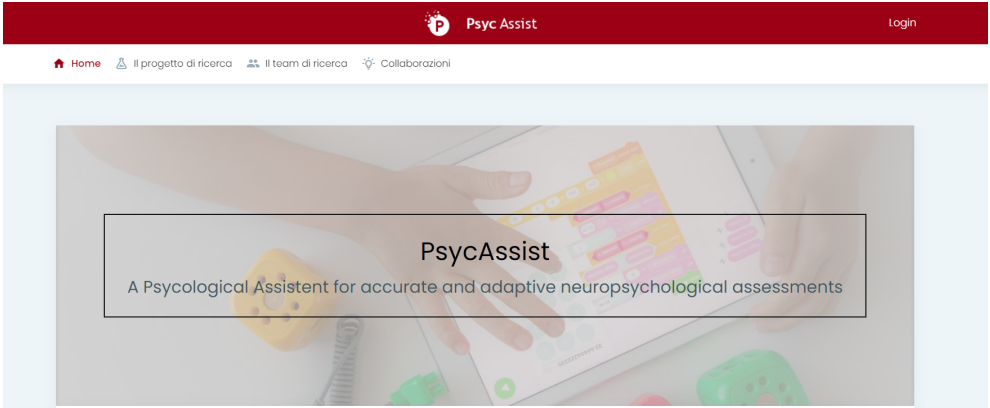

response_list()



`response_list()`



PsycAssist


Psyc Assist
Login
Home
Il progetto di ricerca
Il team di ricerca
Collaborazioni
PsycAssist
A Psycological Assistent for accurate and adaptive neuropsychological assessments
Missione del progetto
Sviluppare un sistema intelligente di web-app per la valutazione neuropsicologica che somministra test, raccoglie e analizza dati, fornisce report personalizzati comprensivi di suggerimenti per la riabilitazione.

Stimuli

40 Raven-like matrices:

- 1×1 matrices (jigsaw puzzle) , $n = 5$
- 2×2 matrices, $n = 20$
- 3×3 matrices, $n = 15$

Sample

$n = 600$ children aged 4-11 ($M = 8.39 \pm 2.17$), recruited in Italian schools
$F = 48\%$
30% preschoolers

Rasch validation

- Monotonicity check
- Fit the Rasch model:
  1. Check for item with infit and/or outfit statistics ≥ 2 (underfit)
  2. Local dependence (Yeun's $Q3 \geq .20$)

Rasch validation

Note

2 matrices were eliminated because of technical issues
4 matrices were eliminated because of a lack of monotonicity

The starting model included 34 matrices:

Madcov	SRMR	p-value
0.95	0.06	0.001

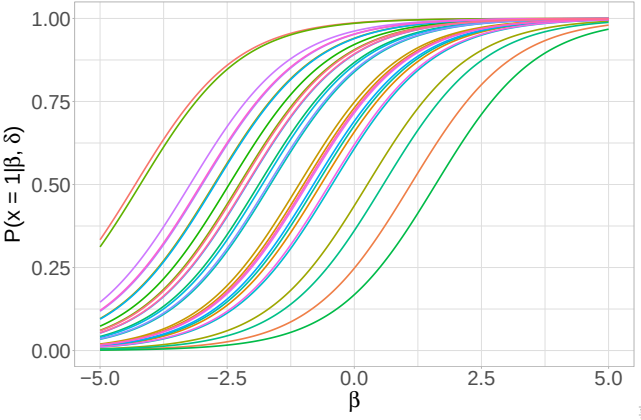
Oufit statistic suggested the underfit of one matrix (item 21) $\rightarrow$ removed and refitted the model

- Check for infit/outfit $\rightarrow$ no matrices were identified as underfitting
- Check for local dependence:
  - Matrix $37 - 40$
  - Matrix $37 - 28$

  $\}$ $\rightarrow$ Matrix 37 has been eliminated

The final model

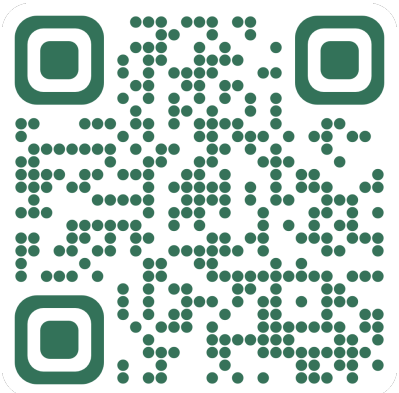
Madcov	SRMR	*p*-value
0.94	0.06	0.001



- Formalization of the matrix generation process → Modulate the stimulus difficulty by varying its elements
- Generate similar but different matrices → Equivalent matrices (?)
- Reproducibility of the stimuli
- Ease of use (for useR)

➡ SOON A shiny app

matRiks



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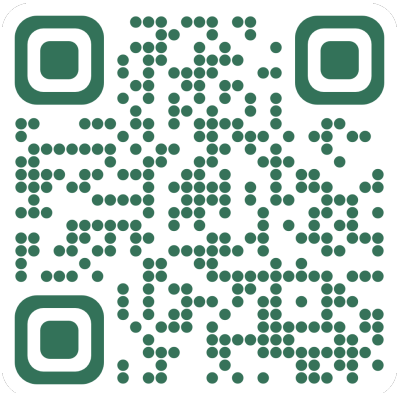

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Thank you!

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useR!