

# MATRIKS

AN R PACKAGE FOR THE AUTOMATIC GENERATION OF  
RAVEN-LIKE MATRICES

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University of Padova, IT

Symposium: New frontiers for the adaptive assessment of executive  
functions

and fluid intelligence

Conference of the Italian Association of Psychology,  
Lucca, September 2023



## 1 Introduction

## 2 Generating rules

## 3 The matRiks package

## 4 Why?

## 5 Final remarks

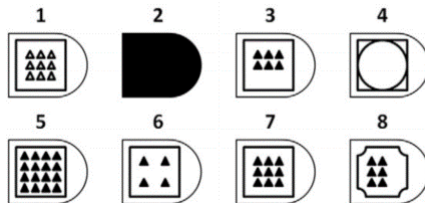
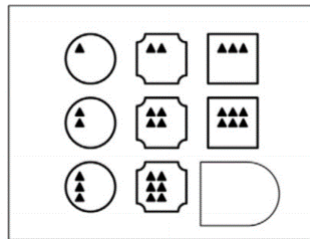


Assessment of fluid intelligence or abstract reasoning

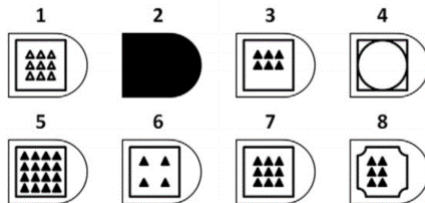
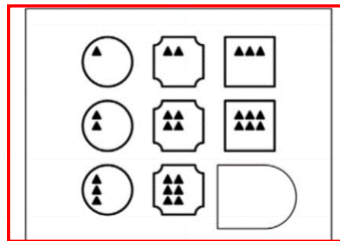
Beyond clinical assessment → Job recruitment



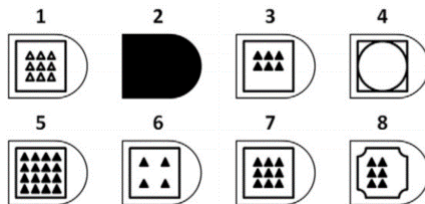
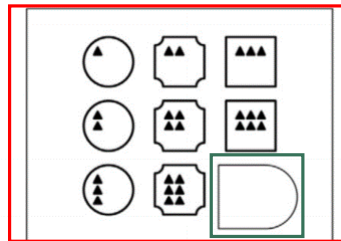
# An example



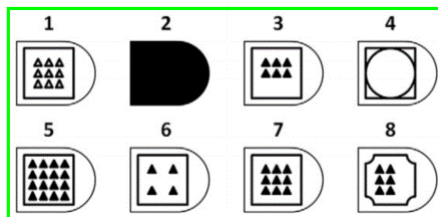
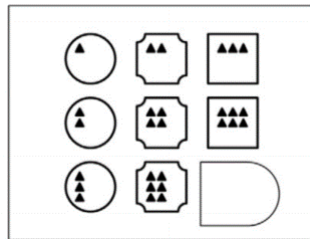
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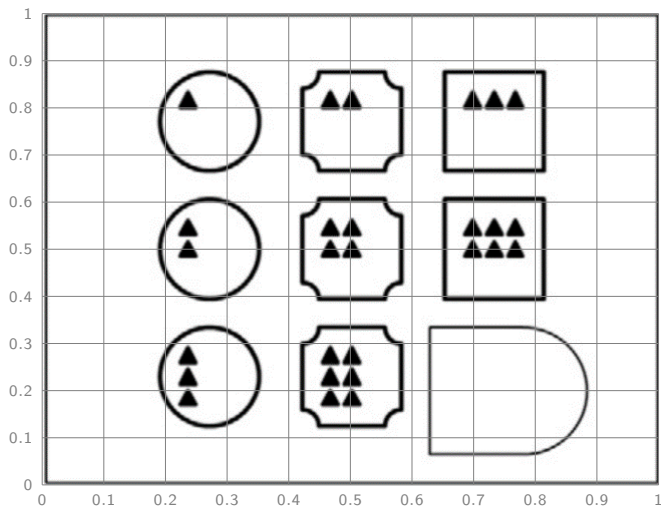
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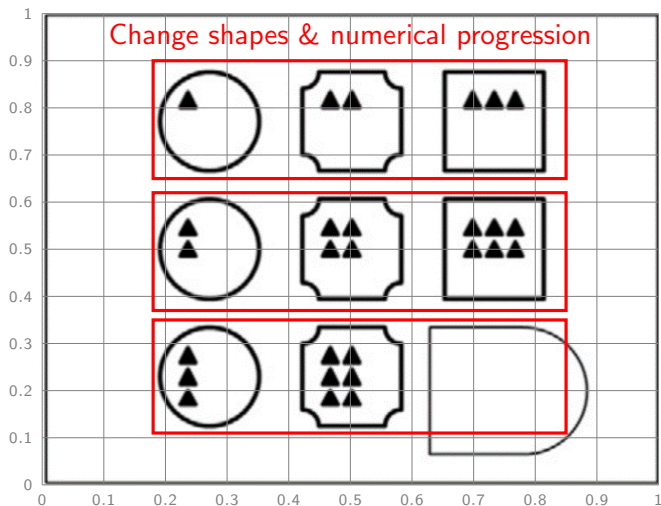


# An example: The matrix

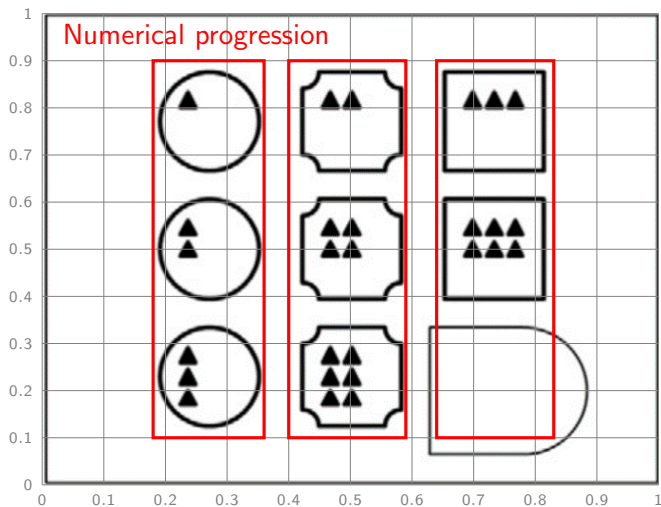




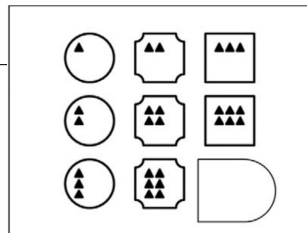
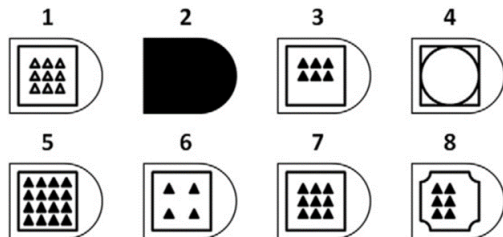
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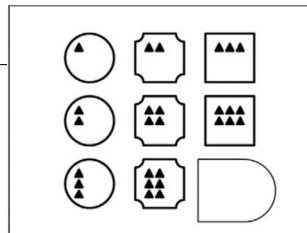
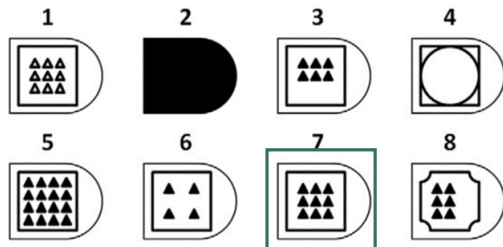
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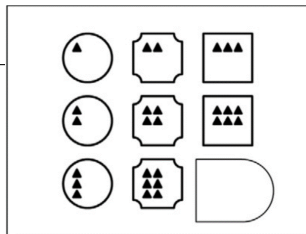
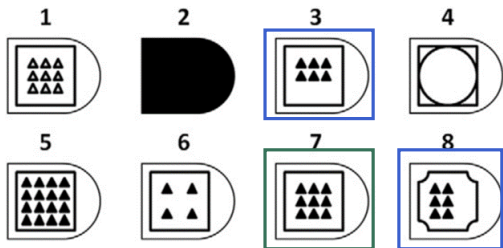
# An example: The response list



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## Repetition

Incomplete Correlate

Wrong Principle

Difference

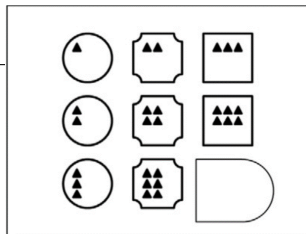
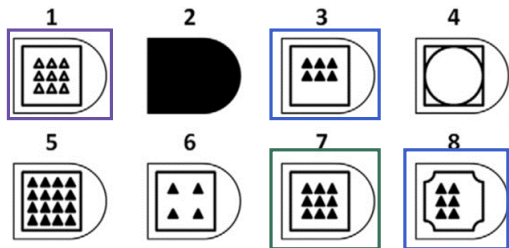
Repetition of a cell adjacent to the blank space

Almost the correct response

Copy of a non adjacent cell or combination of cells

Different in appearance from every element of the matrix

# An example: The response list



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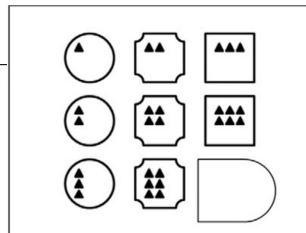
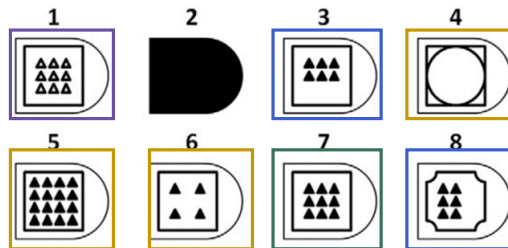
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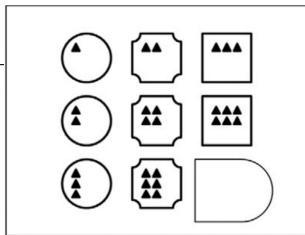
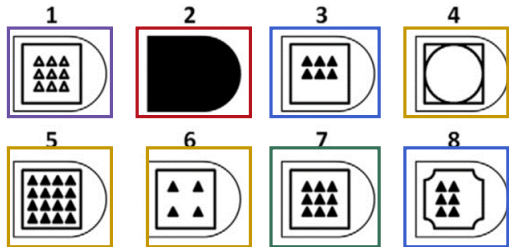
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1 Introduction

2 **Generating rules**

3 The matRiks package

4 Why?

5 Final remarks

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 ( $\Delta$ )
Directional Logic	Horizontal	The objects are modified across columns
	Vertical	The objects are modified across rows
	Diagonal	The objects are modified horizontally and diagonally

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

- Generates  $2 \times 2$  or  $3 \times 3$  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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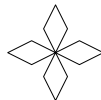
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# (Some) of the available objects

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...

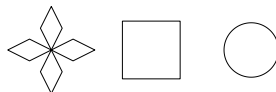
# Visuospatial rules

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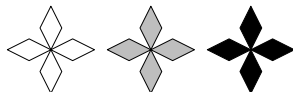
## Rotate



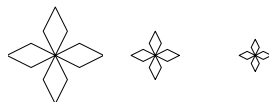
## Shape



## Shade



## Size



...



# Logical rules

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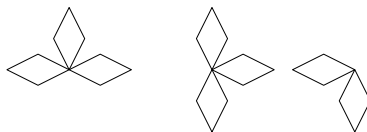
AND ( $\cap$ )



OR ( $\cup$ )



XOR ( $\Delta$ )



# Matriks generator

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Rule

# Matriks generator

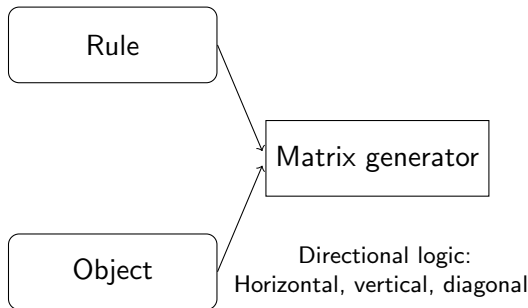
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Rule

Object

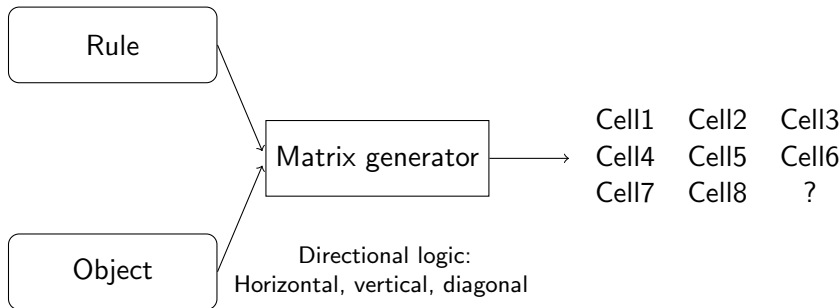
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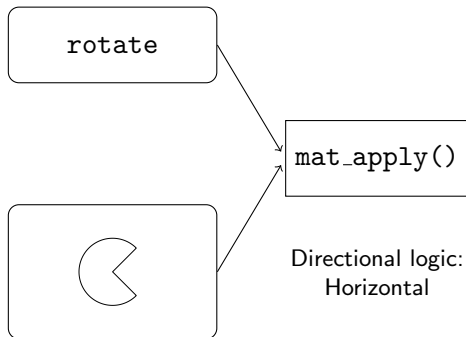
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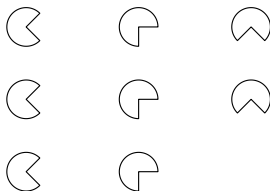
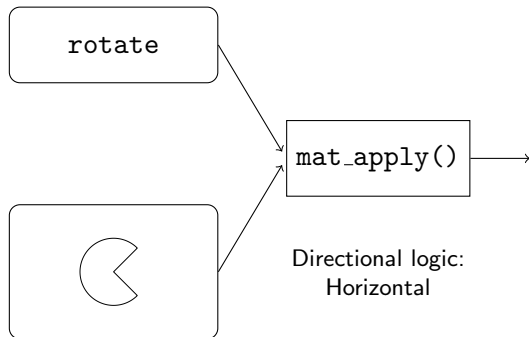
rotate

rotate









# 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

---

Cell1	Cell2	Cell3
Cell4	Cell5	Cell6
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Response options generator →

Correct	×1
Repetition	×3
Incomplete Correlate	×4
Wrong Principle	×2
Difference	×1

Introduction  
ooooo

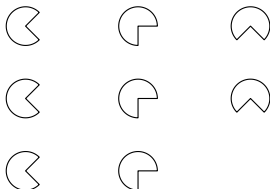
Generating rules  
oo

The matRiks package  
oooooooo●

Why?  
ooooo

Final remarks  
ooo





`response_list()`

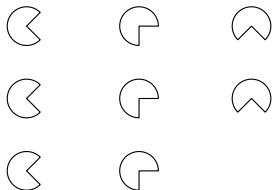
Introduction  
ooooo

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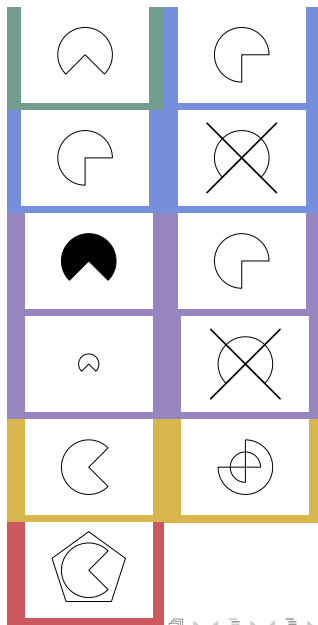
The matRiks package  
oooooooo●

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ooo



response\_list()



Introduction  
○○○○○

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○○

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# PsycAssist



Psyc Assist

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## PsycAssist

A Psychological Assistant 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:

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

# Stimuli

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## 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  $\geq 2$  (underfit)
  - ② Local dependence (Yeon's  $Q3 \geq .20$ )

# Rasch validation

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## 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:

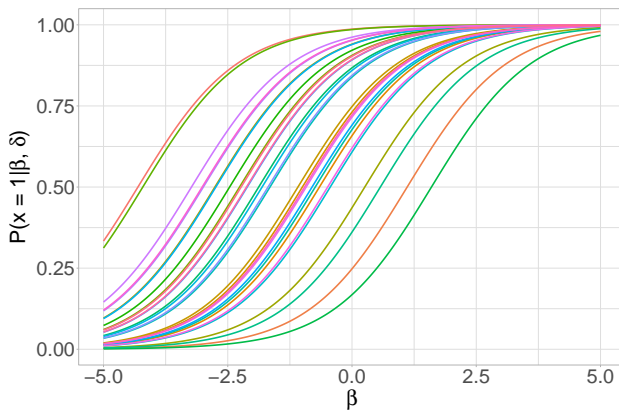
Madcov	SRMR	<i>p</i> -value
0.95	0.06	0.001

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

- Check for infit/outfit → no matrices were identified as underfitting
- Check for local dependence:
  - Matrix 37 – 40
  - Matrix 37 – 28 } → Matrix 37 has been eliminated

# The final model

Madcov	SRMR	$p$ -value
0.94	0.06	0.001



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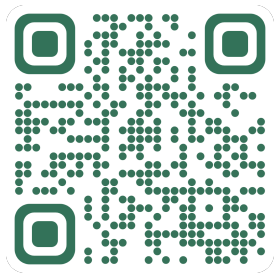
- Formalization of the matrix generation
- Generate similar but different matrices → Equivalent matrices (?)
- Reproducibility of the stimuli
- Ease of use (for useR)

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 SOON A shiny app

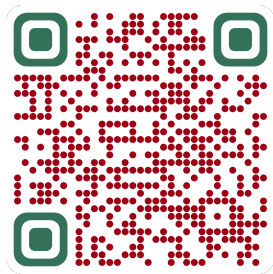


matRiks

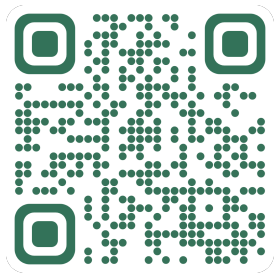


<https://github.com/OttaviaE/matRiks>

Slides

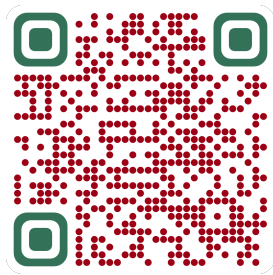


matRiks



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Slides



Thank you!

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