

MATRIKS

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

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Pasquale Anselmi, Luca Stefautti

Universty of Padova, IT

Meeting of the European Mathematical Psychology Group, 2023



1 Introduction

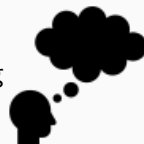
2 Generating rules

3 The matRiks package

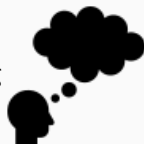
4 Why?

5 Final remarks

Assessment of fluid intelligence or abstract reasoning
Beyond clinical assessment → Job recruitment



Assessment of fluid intelligence or abstract reasoning
Beyond clinical assessment → Job recruitment

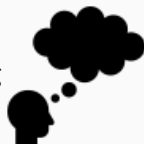


Issue

- Can only be administered once (or after a long time period)
- Difficulty in the generation of “true” parallel forms



Assessment of fluid intelligence or abstract reasoning
Beyond clinical assessment → Job recruitment



Issue

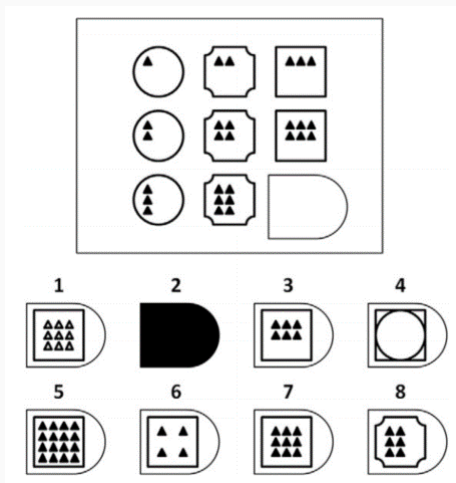
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Aim

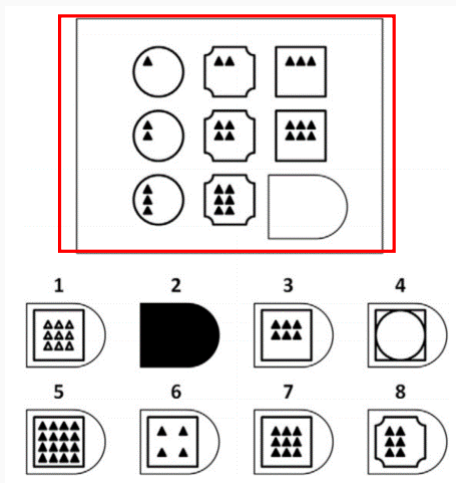
Development of an open-source easy-to-use tool for the automatic and rule-based generation of Raven-like matrices



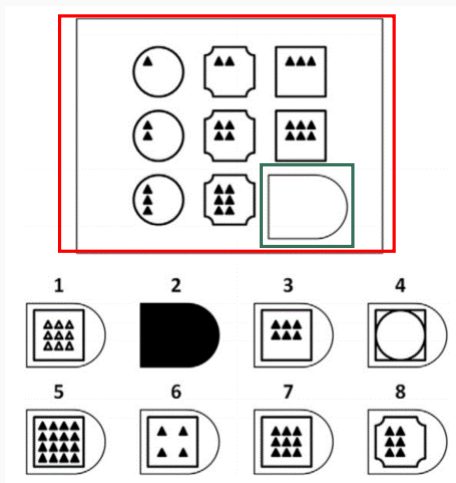
An example



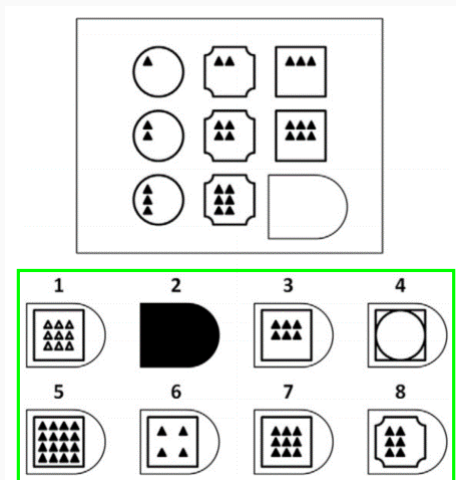
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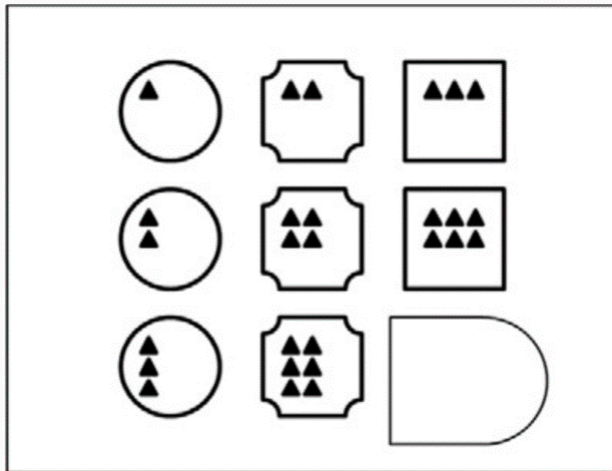
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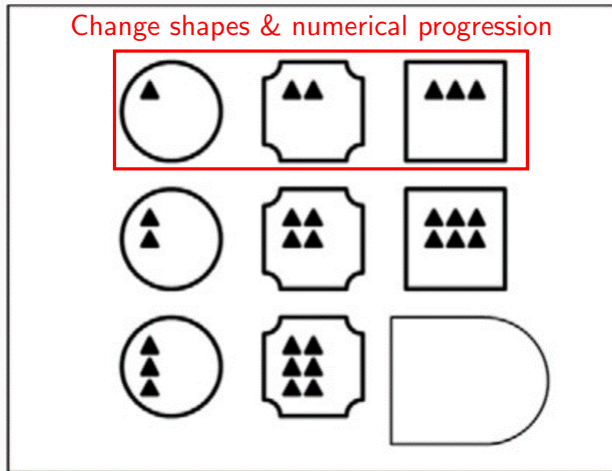
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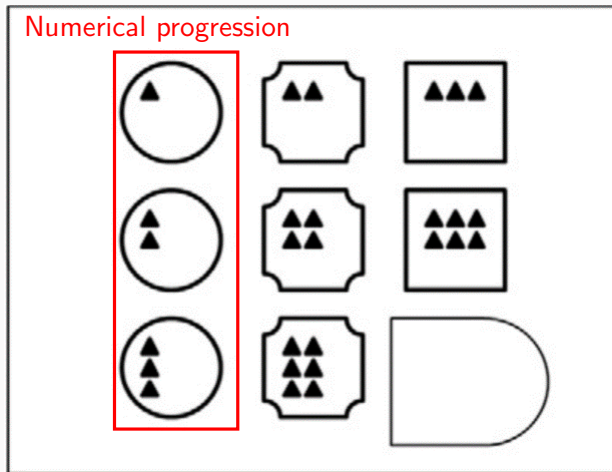
An example: The matrix



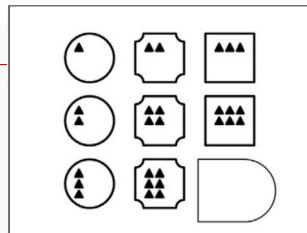
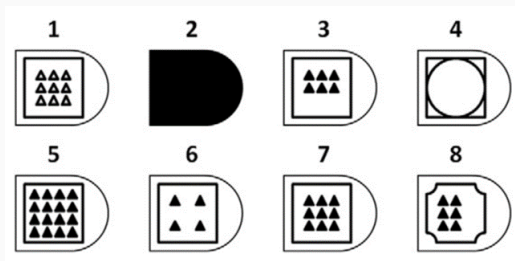
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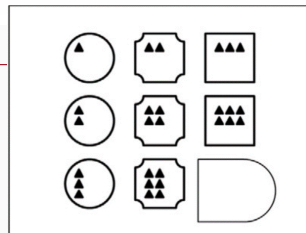
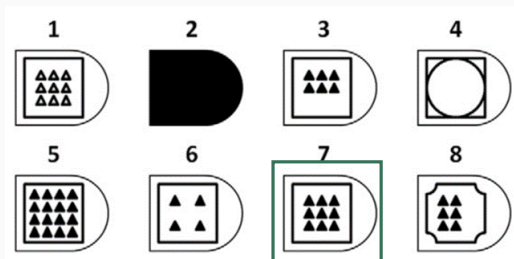
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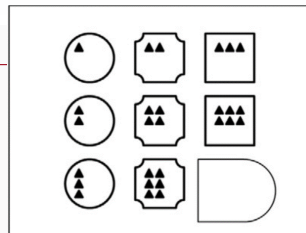
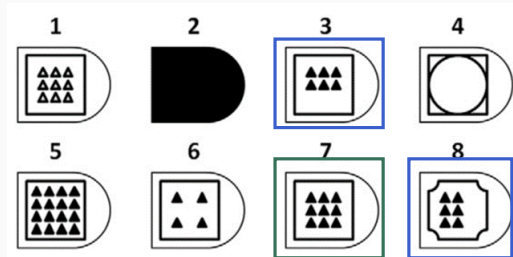
An example: The response list



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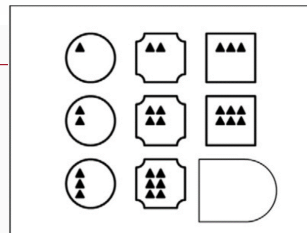
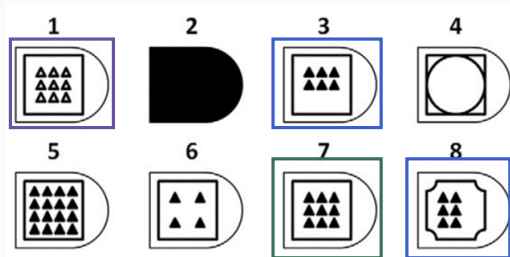


Repetition

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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Wrong Principle

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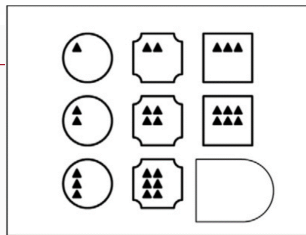
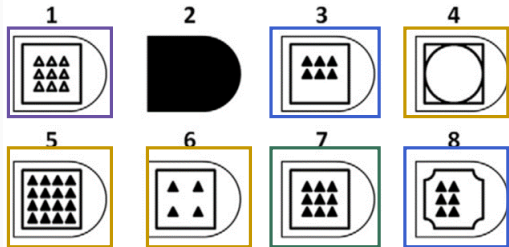
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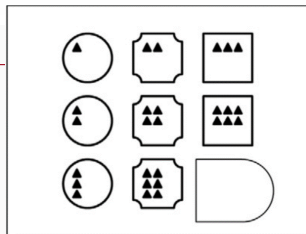
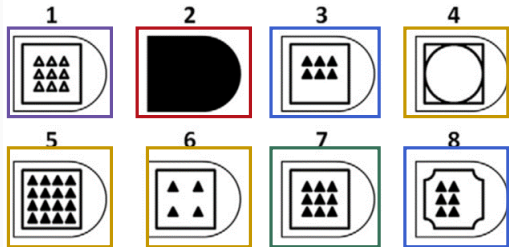
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1 Introduction

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
Logical	Changes in outline	Change the outline of the objects across cells
	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)

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```
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*

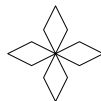


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(Some) of the available objects



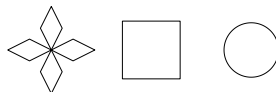
...

Visuospatial rules

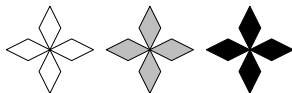
Rotate



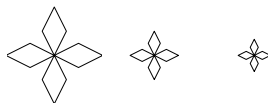
Shape



Shade



Size



...

Logical rules

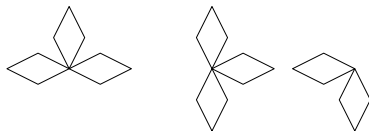
AND (\cap)



OR (\cup)



XOR (Δ)



The matRiks architecture: Matriks generator

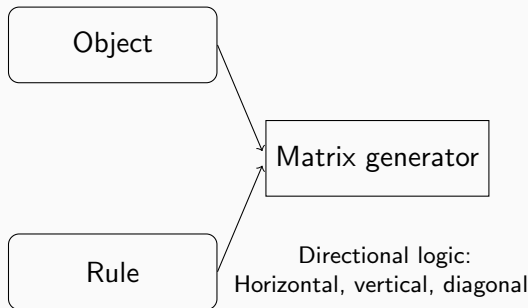
Object

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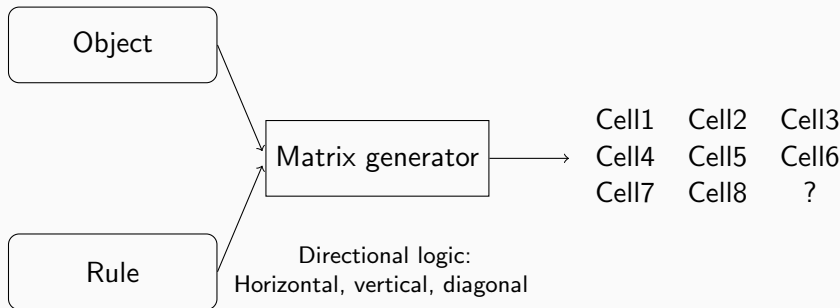
Object

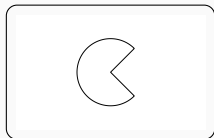
Rule

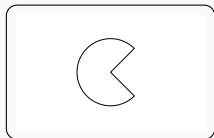
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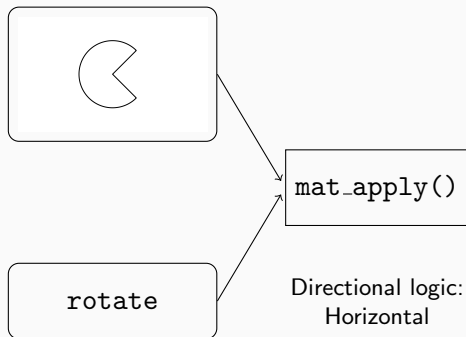
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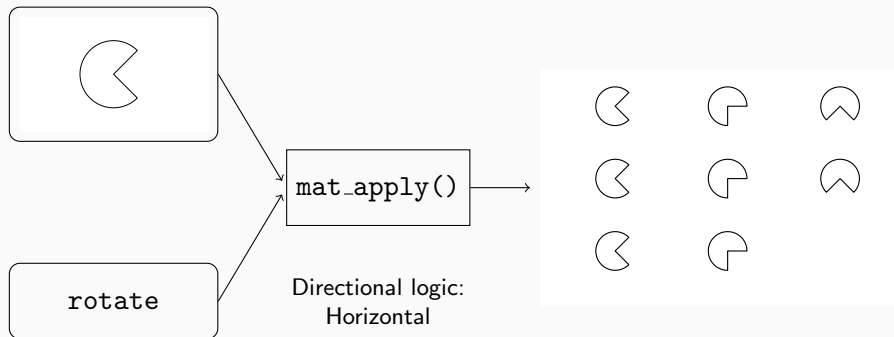






rotate





The matRiks architecture: Response options generator

Cell1	Cell2	Cell3
Cell4	Cell5	Cell6
Cell7	Cell8	?

The matRiks architecture: Response options generator

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Response options generator

The matRiks architecture: 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

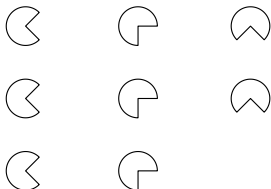
Generating rules
oo

The matRiks package
oooooooo●

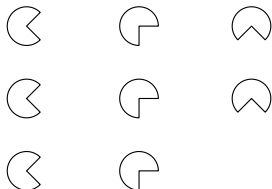
Why?
ooooo

Final remarks
ooo

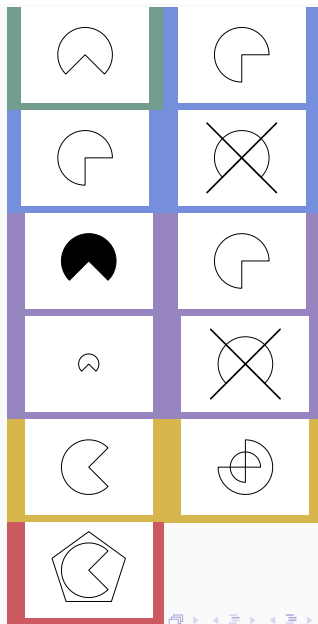
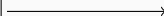




```
response_list()
```

`response_list()`



1 Introduction

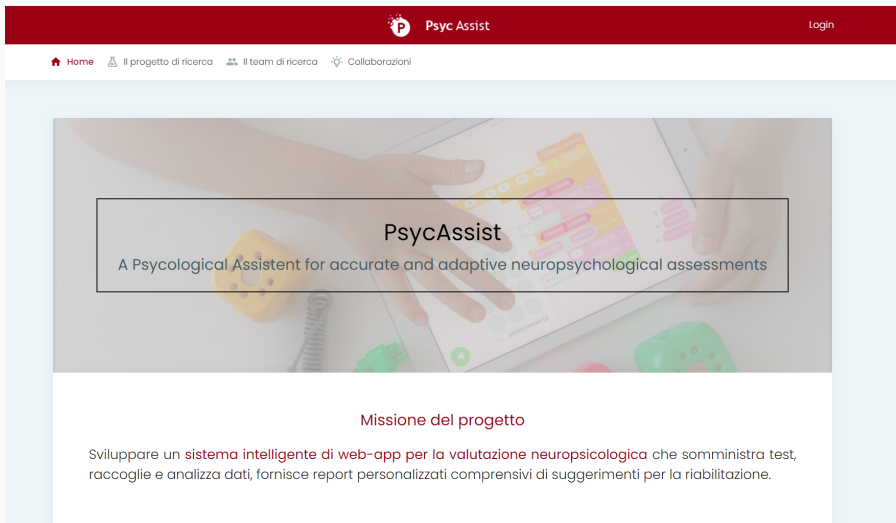
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PsycAssist



The screenshot shows the PsycAssist website. At the top is a dark red navigation bar with a 'P' logo, the text 'Psyc Assist', and a 'Login' link. Below this is a lighter red horizontal bar containing navigation links: 'Home' (with a house icon), 'Il progetto di ricerca' (with a magnifying glass icon), 'Il team di ricerca' (with a group of people icon), and 'Collaborazioni' (with a star icon). The main content area has a light blue background. It features a large banner image of hands interacting with a tablet displaying colorful data charts. Overlaid on this image is a white box with the text 'PsycAssist' and 'A Psychological Assistant for accurate and adaptive neuropsychological assessments'. Below the banner, the heading 'Missione del progetto' is followed by a paragraph describing the project's goal: to develop a web-app for neuropsychological evaluation that administers tests, collects and analyzes data, and provides personalized reports with rehabilitation suggestions.

Psyc Assist Login

Home Il progetto di ricerca Il team di ricerca Collaborazioni

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:

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

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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 ≥ 2 (underfit)
 - ② Local dependence (Yeu'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	<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

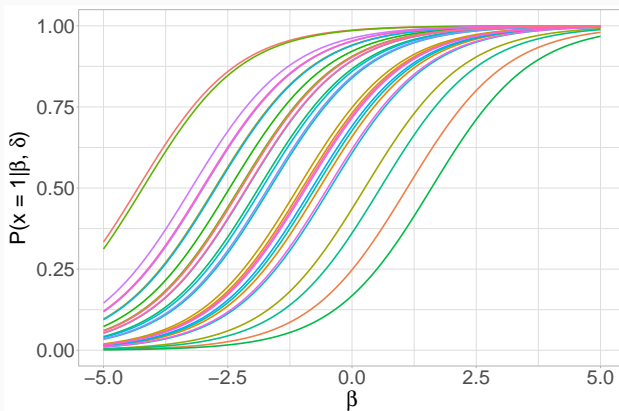
- Check for infit/outfit → no matrices were identified as underfitting
- Check for local dependence:
 - Matrix 37 – 40
 - Matrix 37 – 28 } → Matrix 37 has been eliminated

The final model

Madcov	SRMR	p -value
0.94	0.06	0.001

The final model

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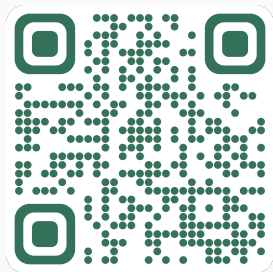
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- Generate similar but different matrices → parallel forms
- Formalization of the matrix generation and response options generation processes
- Reproducibility of the stimuli
- Ease of use (for useR)

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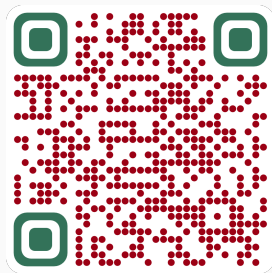
 SOON A shiny app

matRiks

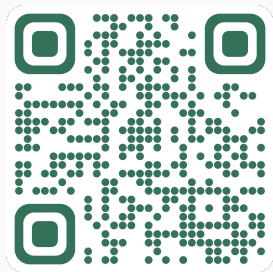


<https://github.com/OttaviaE/matRiks>

Slides

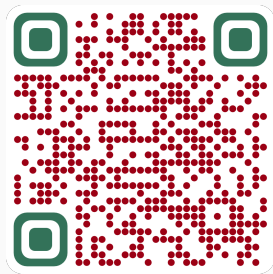


matRiks



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Slides



Thank you!

ottavia.epifania@unipd.it

