# matRiks

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

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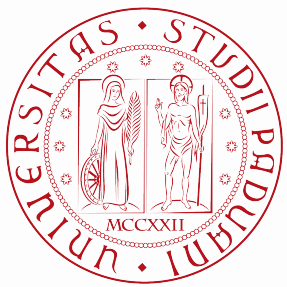
MathPsych, ICCM, EMPG, July 2023



1 Introduction

2 Generating rules

3 The matRiks package

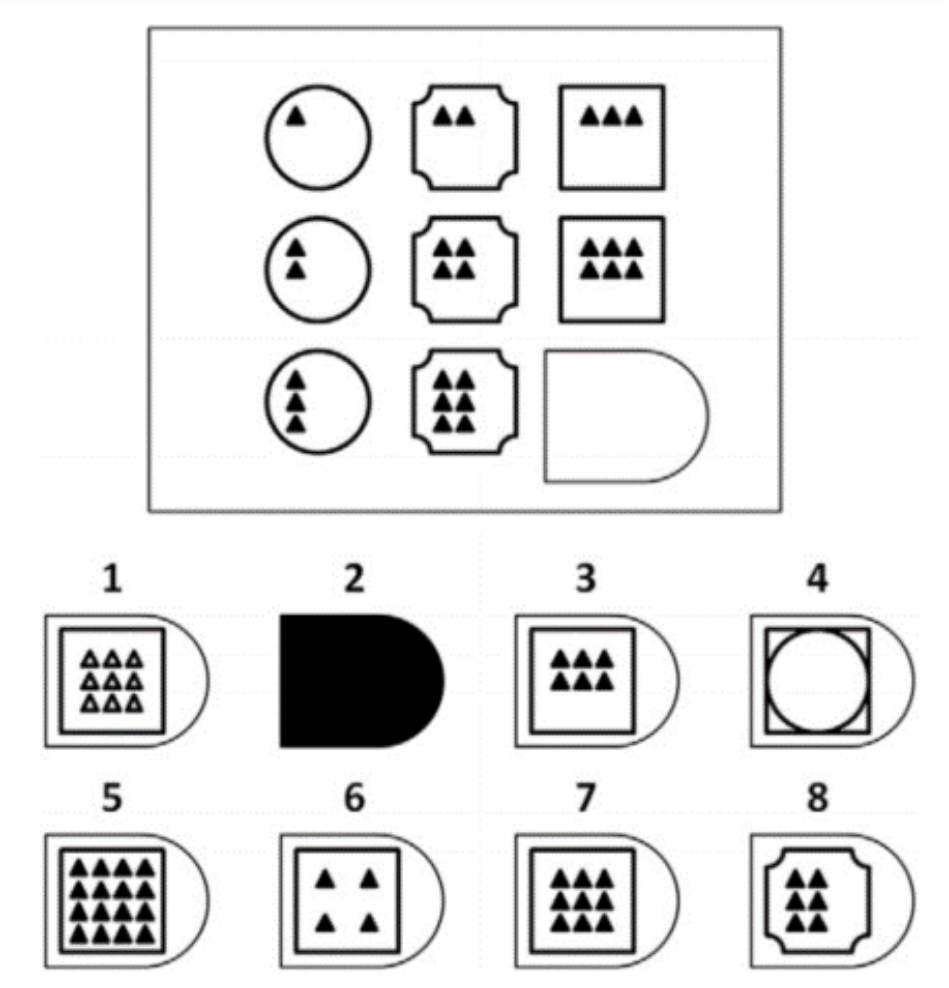
4 Why?

5 Final remarks

Assessment of fluid intelligence or abstract reasoning

Beyond clinical assessment $\rightarrow$ Job recruitment

# An example



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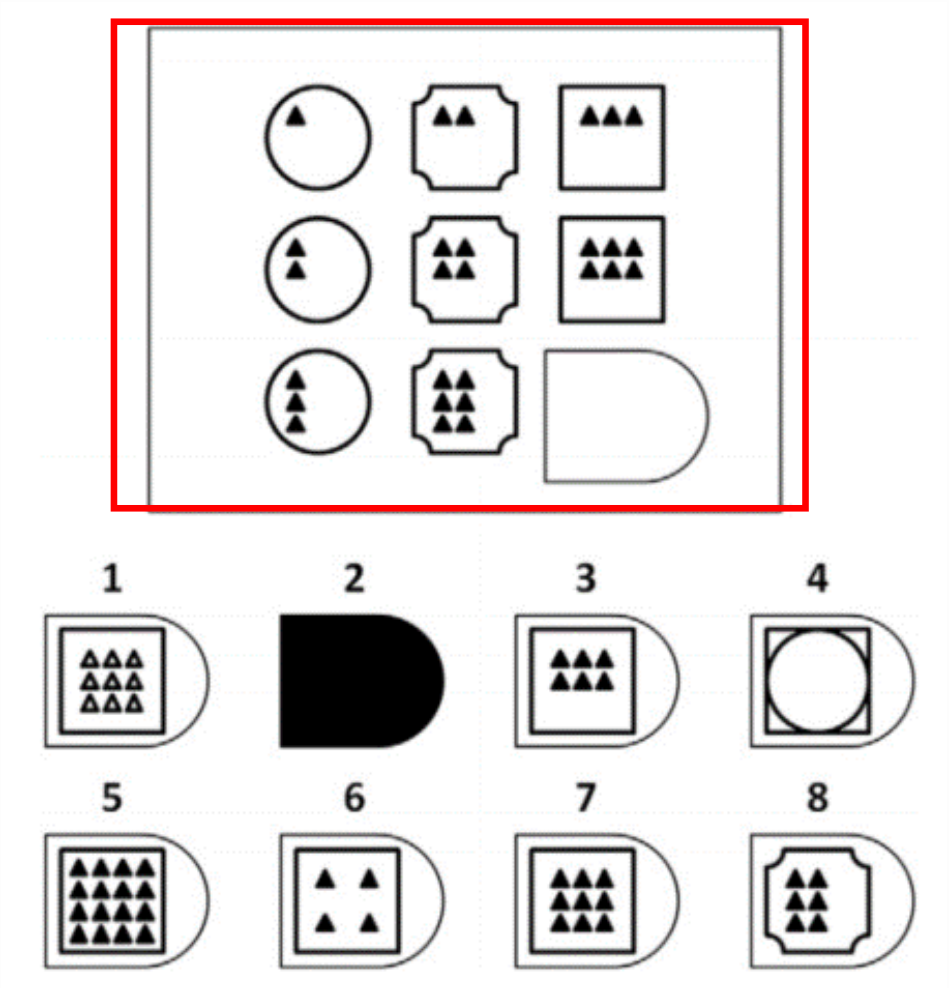

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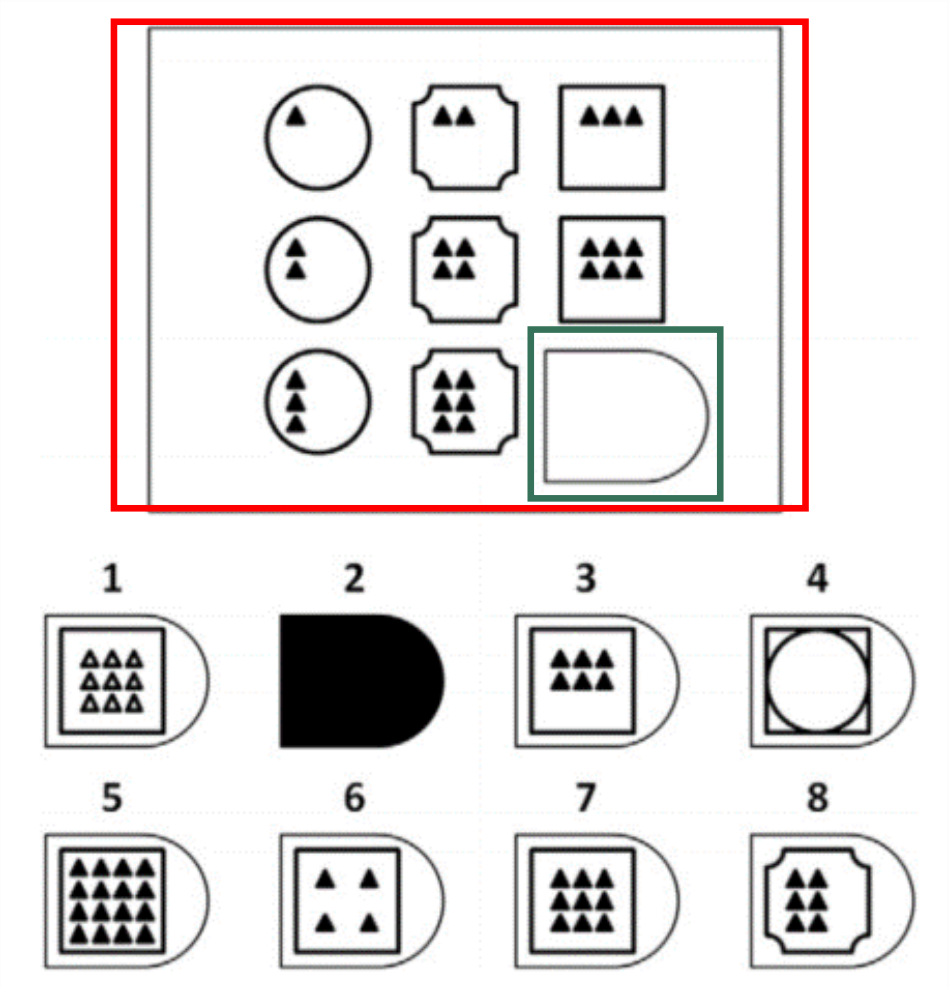

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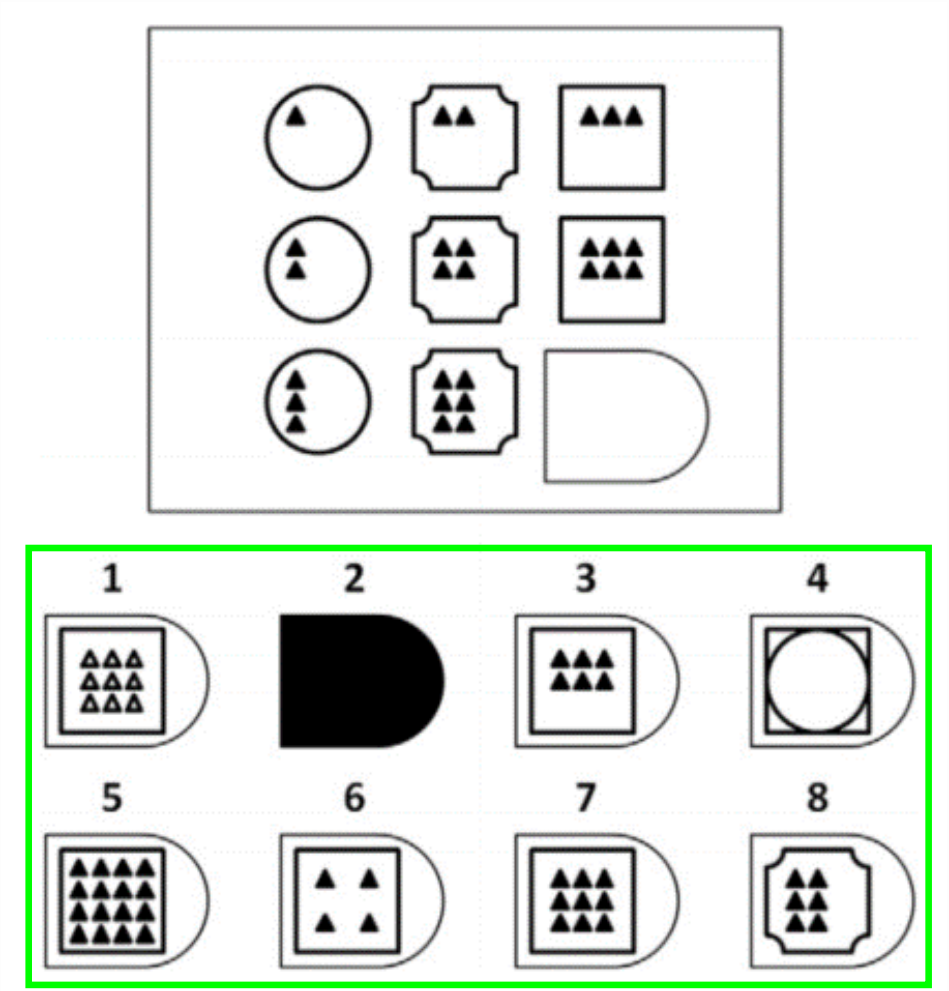

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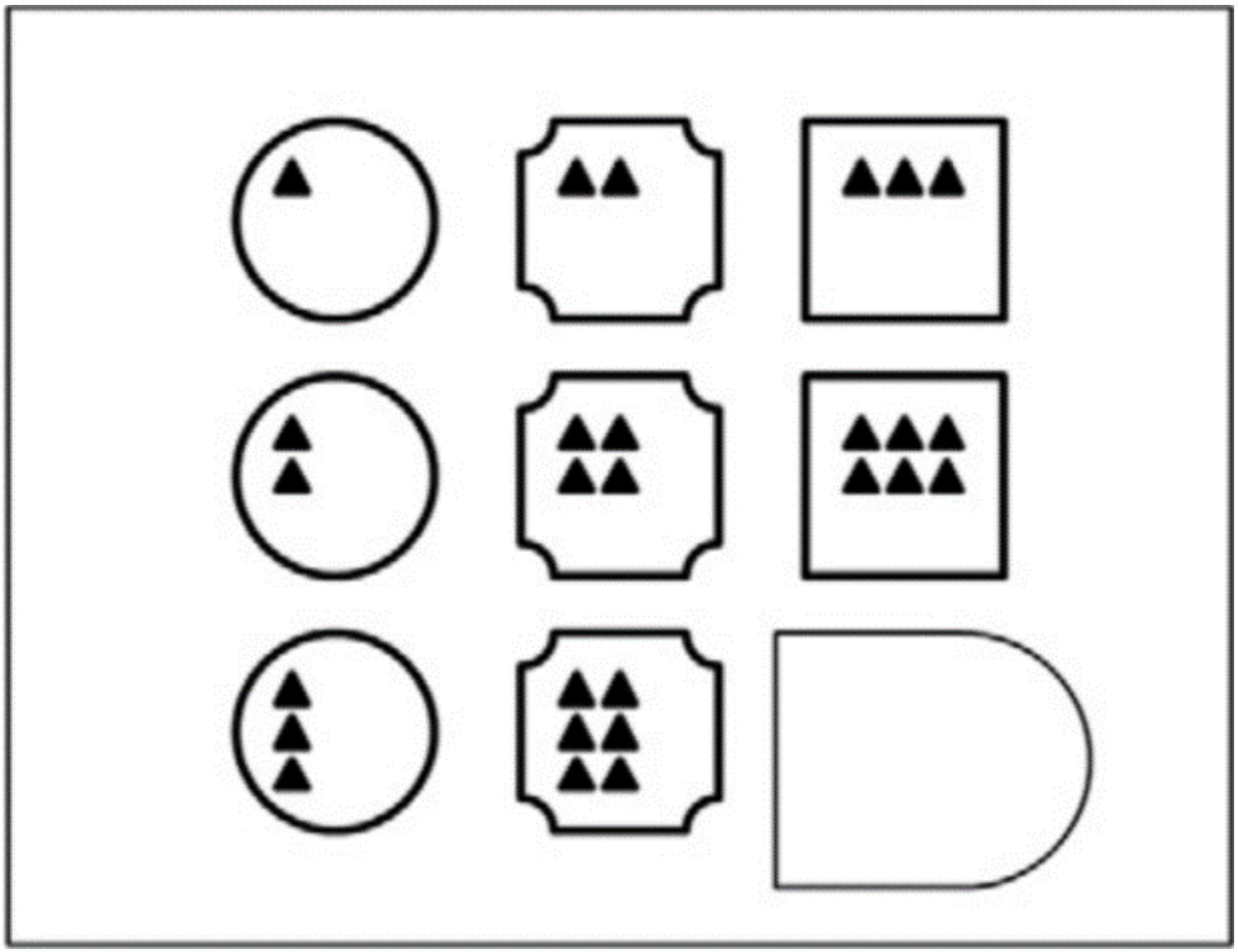

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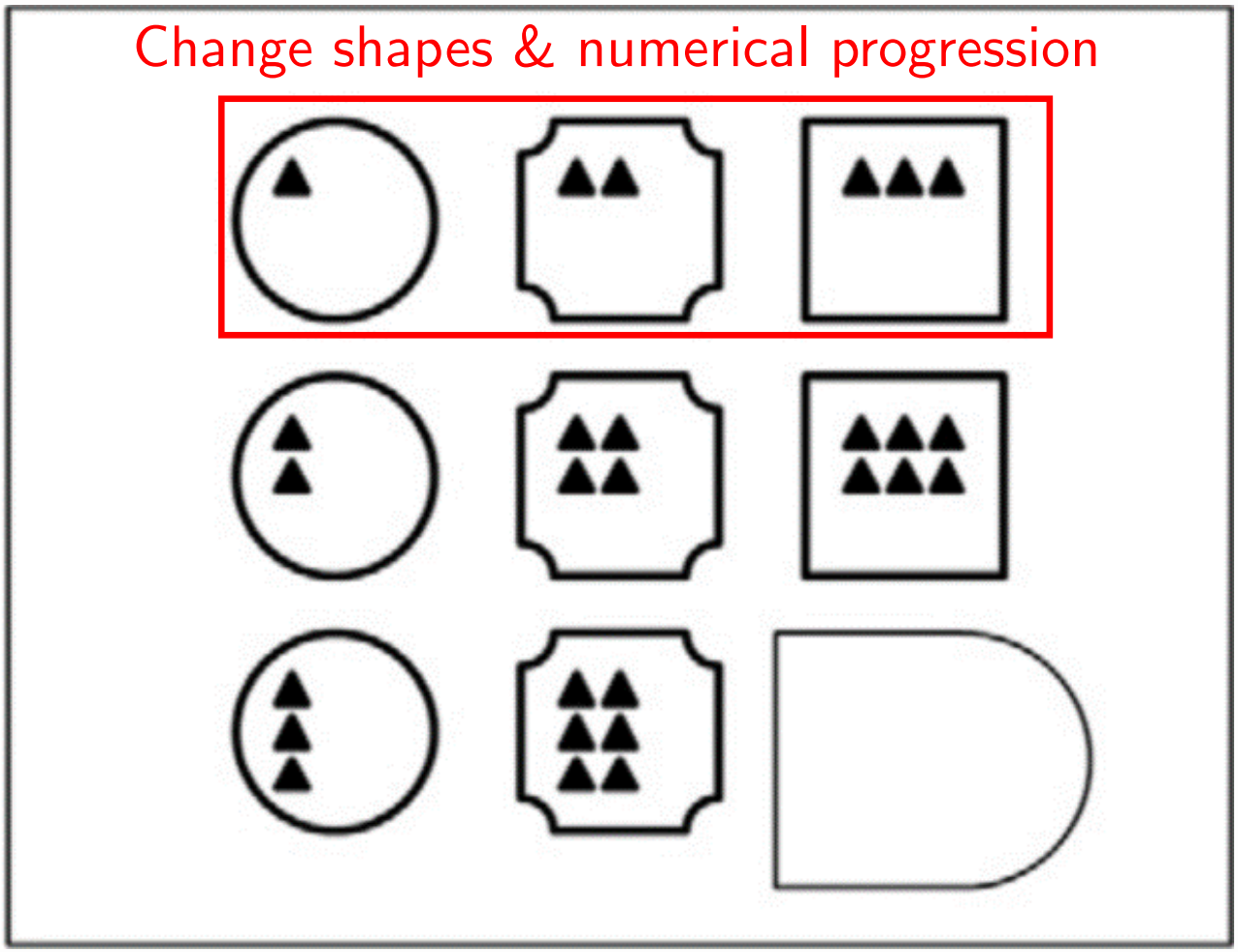

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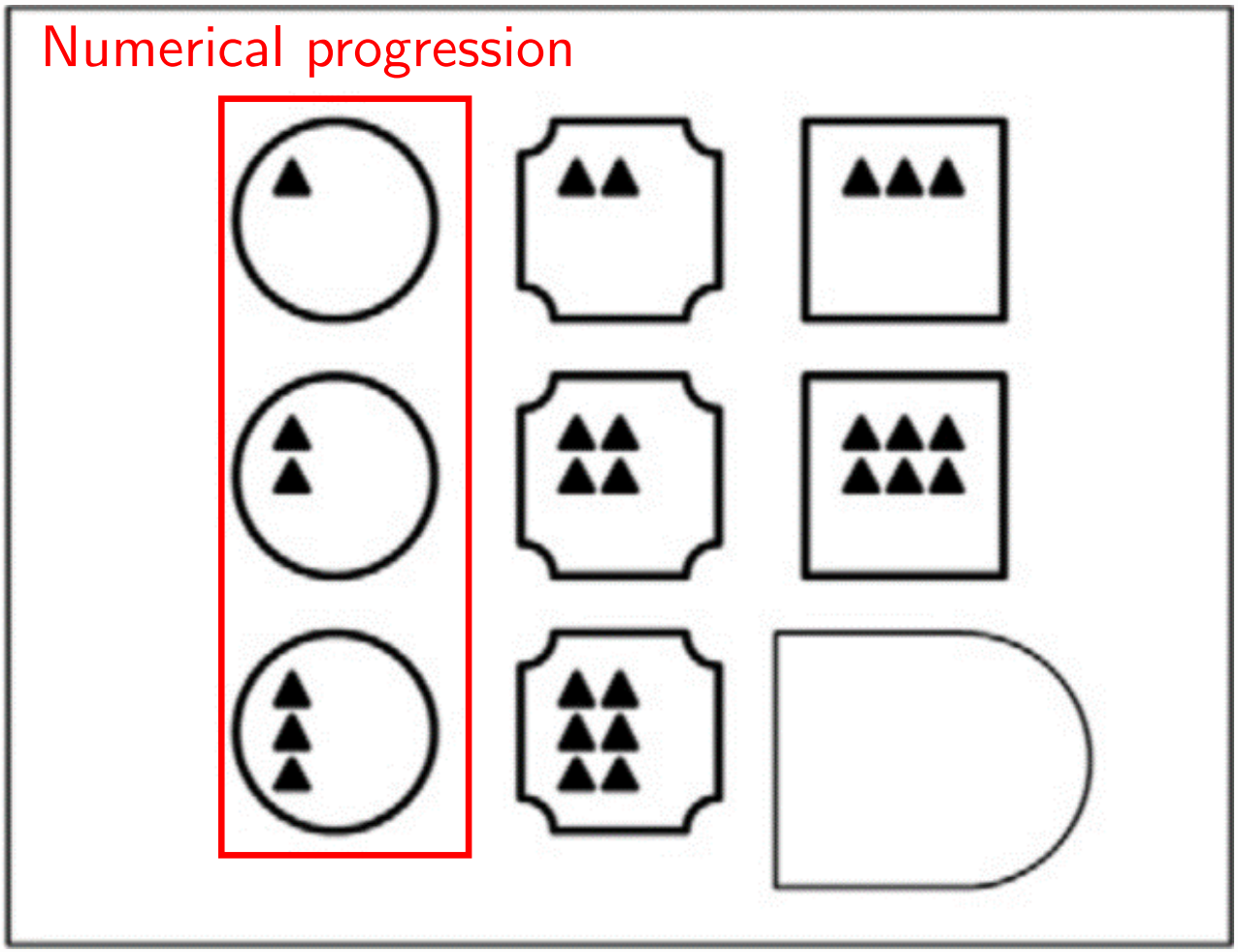

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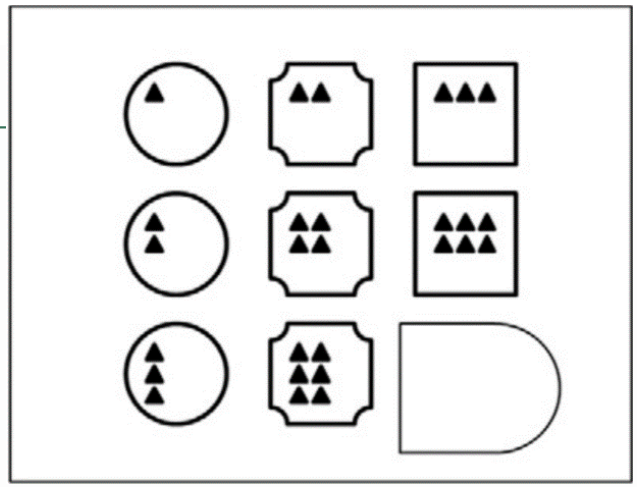

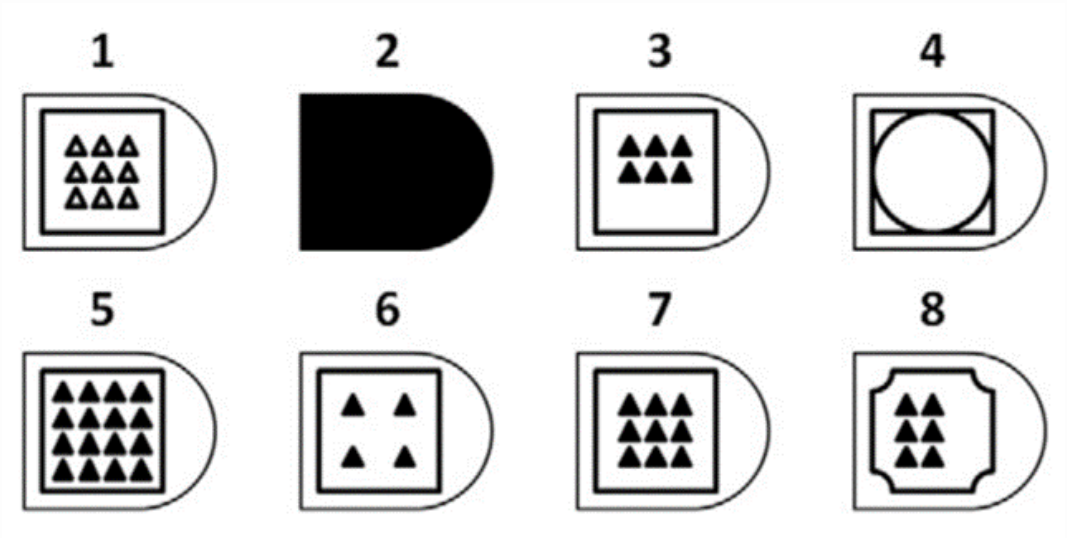

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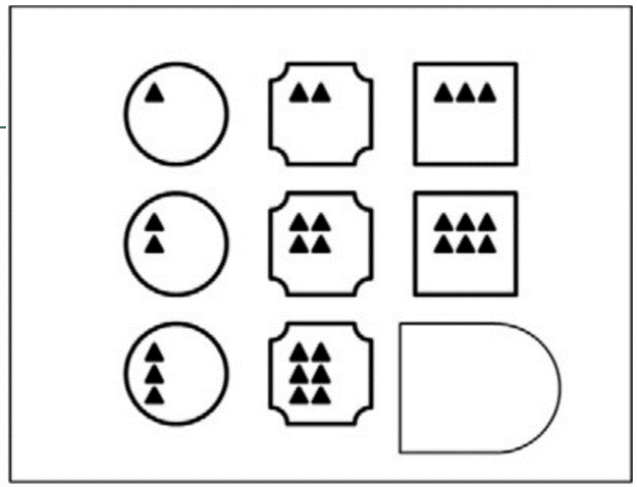

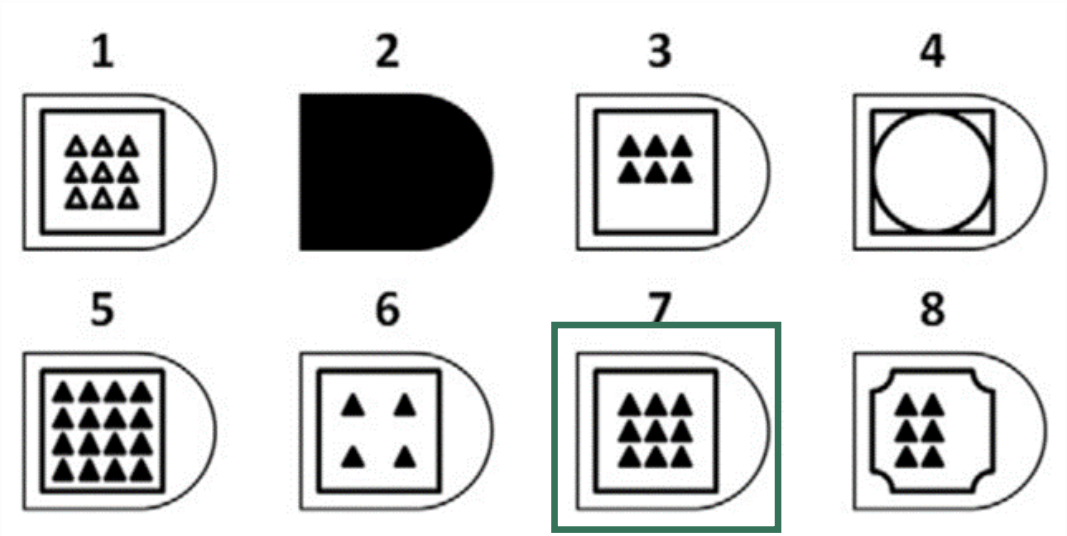

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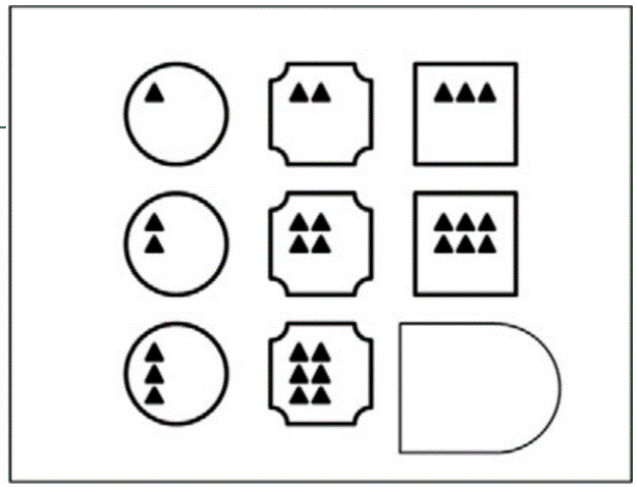

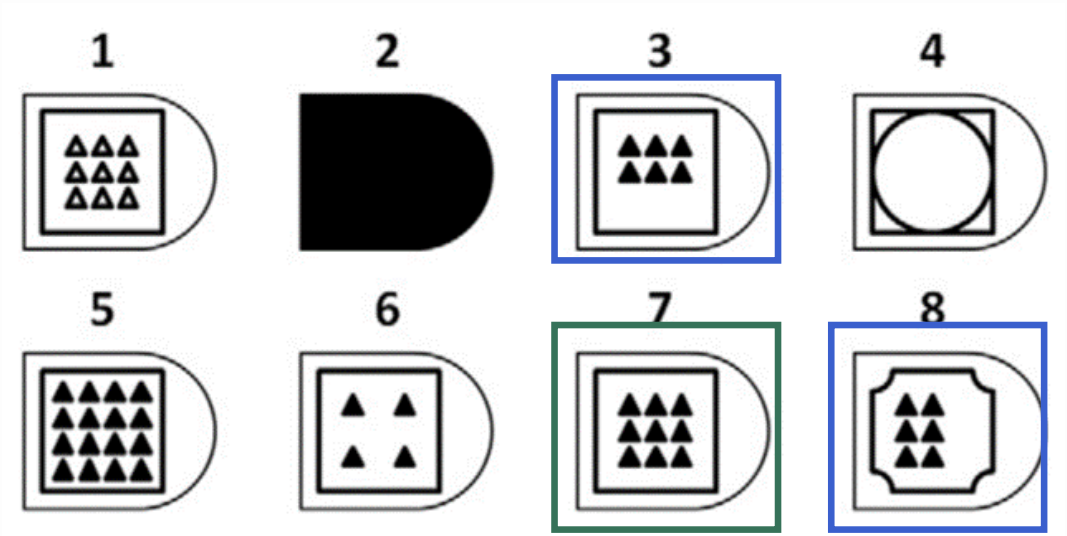


| | |
|---|---|
| Repetition | Repetition of a cell adjacent to the blank space |
| Incomplete Correlate | Almost the correct response |
| Wrong Principle | Copy of a non adjacent cell or combination of cells |
| Difference | Different in appearance from every element of the matrix |

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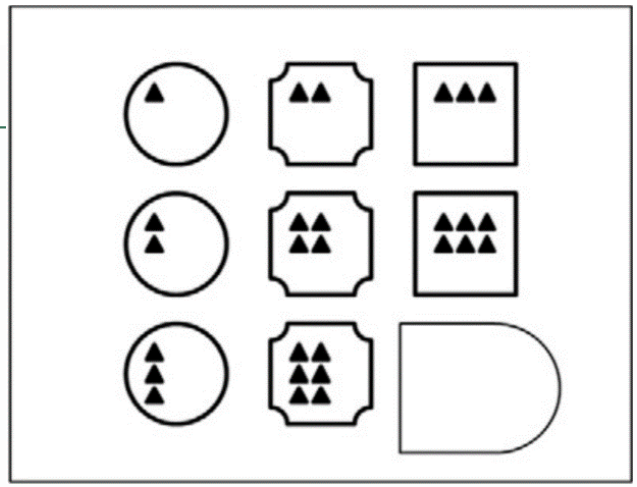

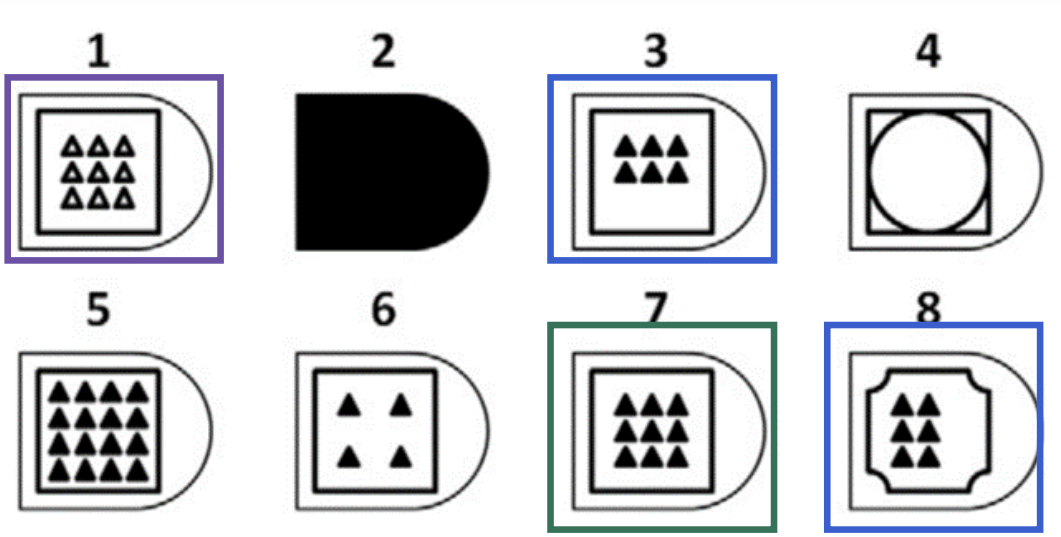


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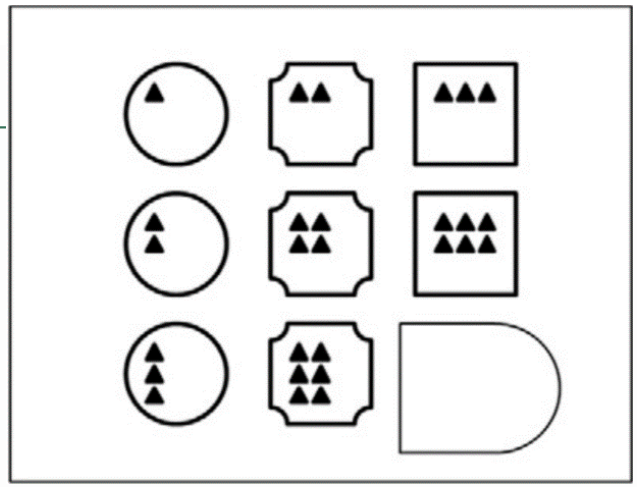

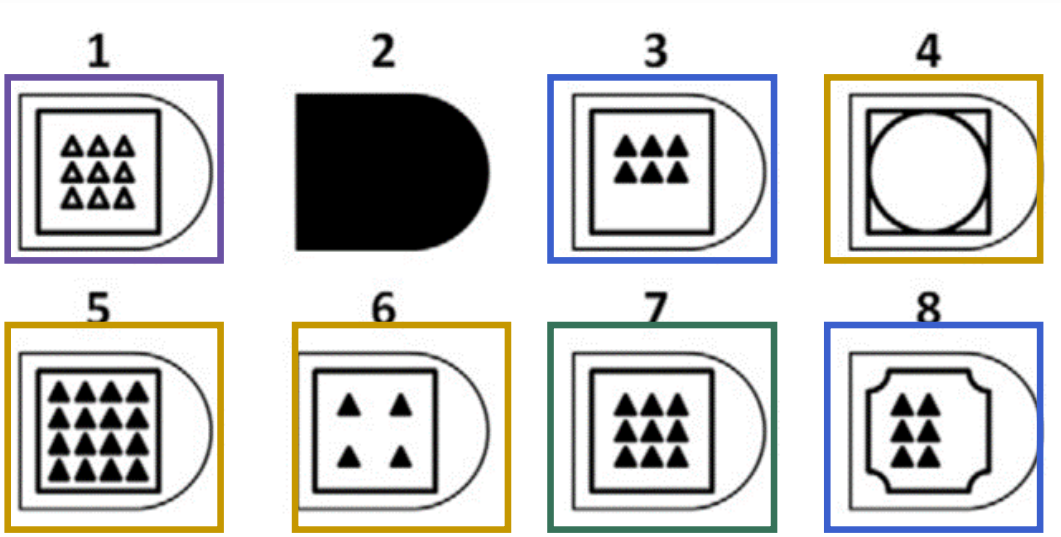


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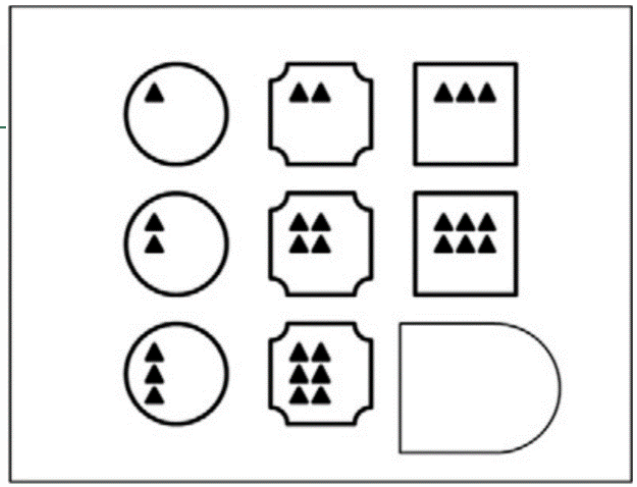

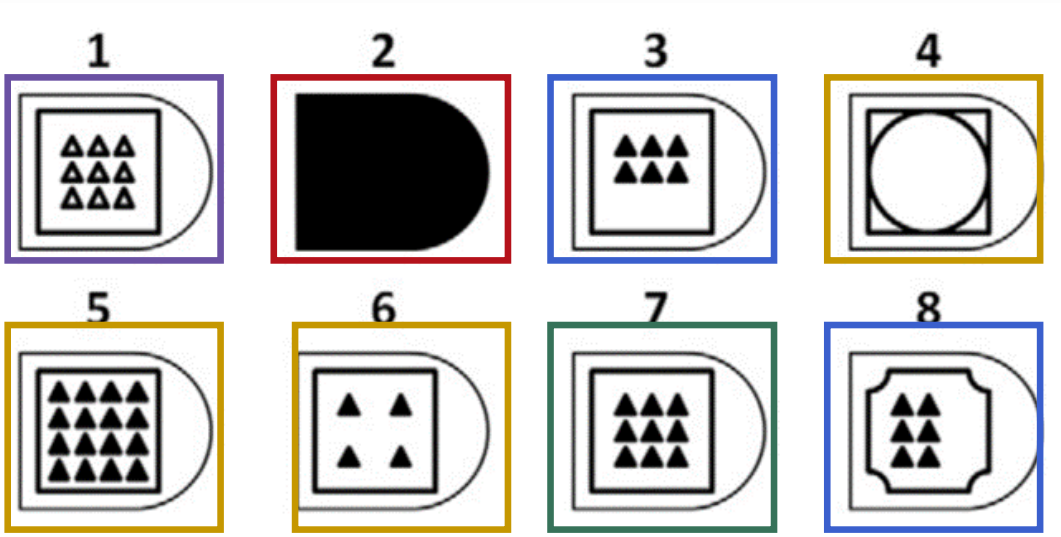


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| Category | Rule name | Definition |
|---|---|---|
| Visuospatial | Object addition | Visually merge two objects |
| | Movement | Change the position of an object across the cells |
| | Rotation | Change the spatial orientation of the objects across 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 ($\Delta$) |

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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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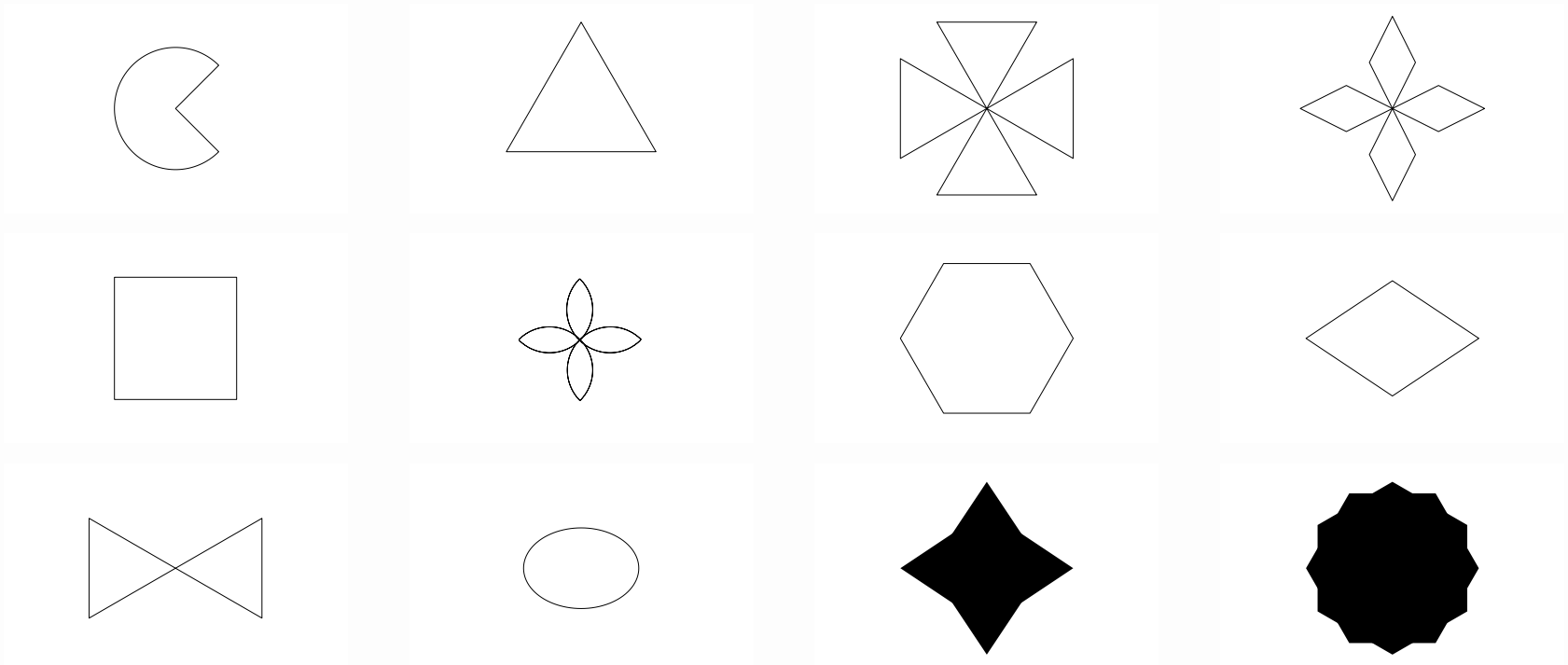
# (Some) of the available objects



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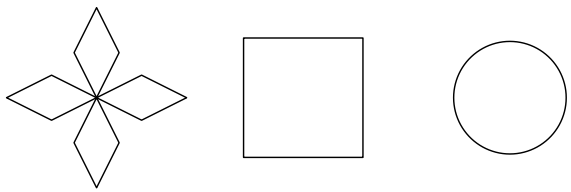
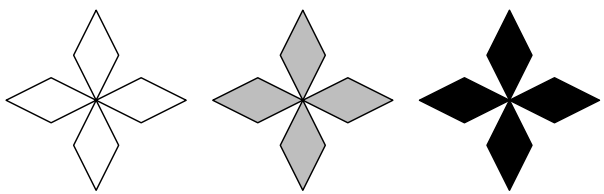
# Visuospatial rules

Rotate

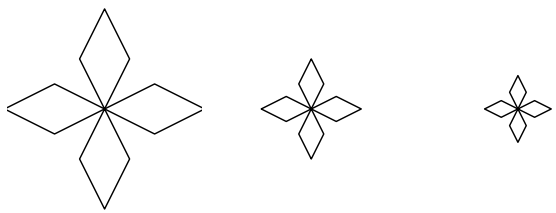
Shape



Shade



Size



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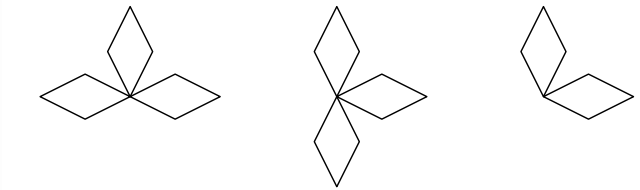
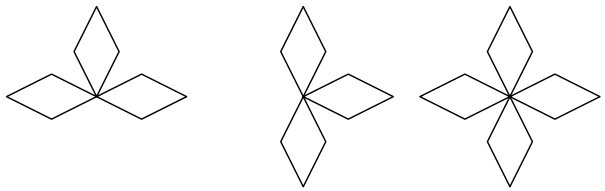
# Logical rules

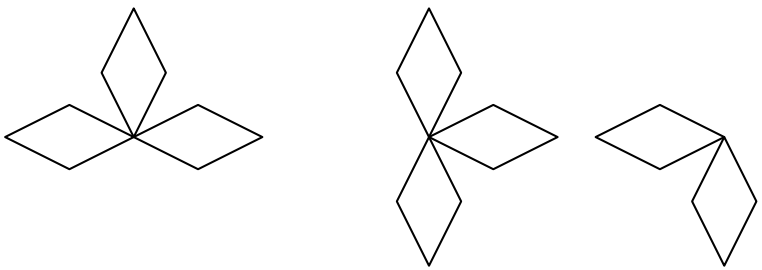
AND ($\cap$)



OR ($\cup$)



XOR ($\Delta$)



# The matRiks architecture: Matriks generator

Object

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Object

Rule

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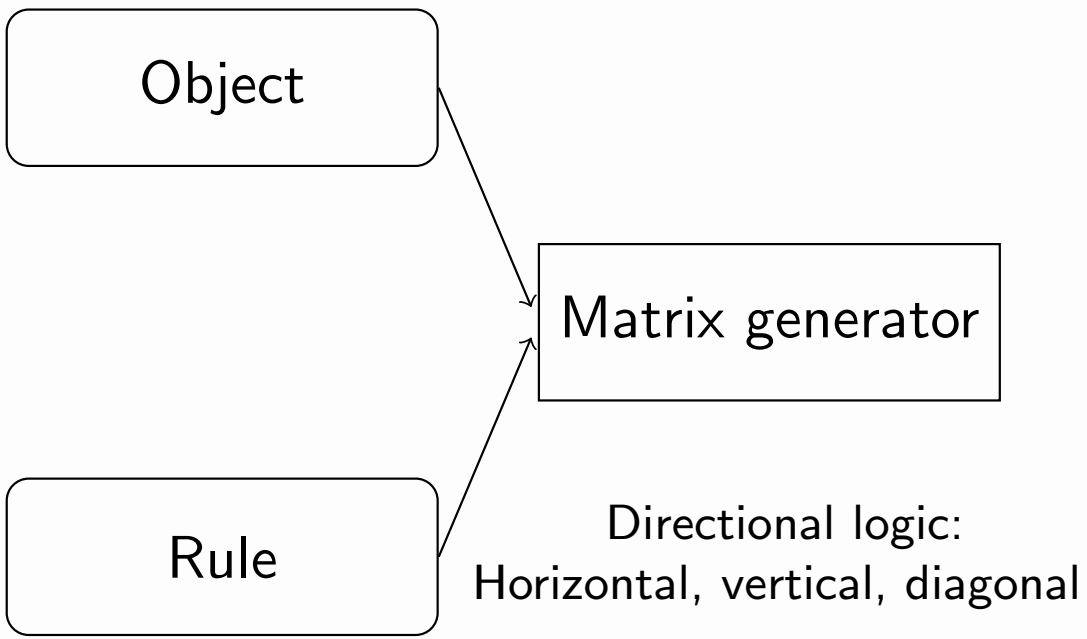

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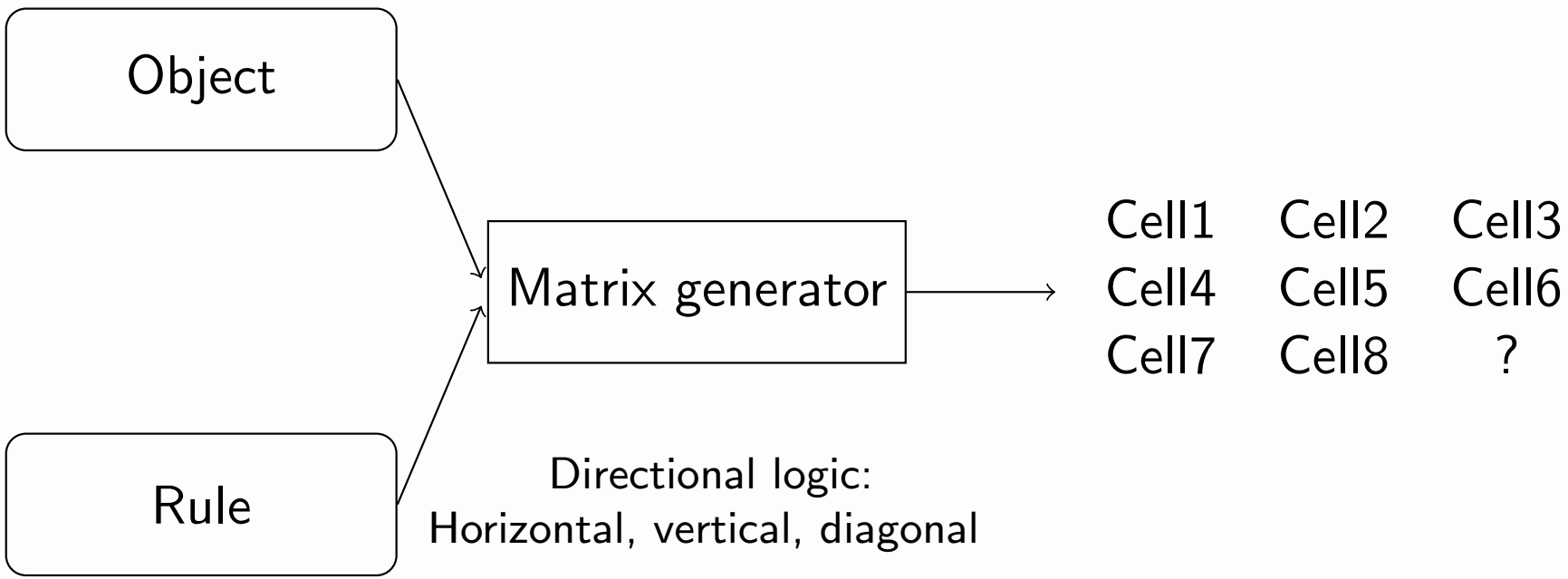
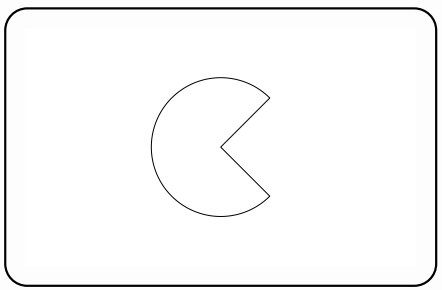
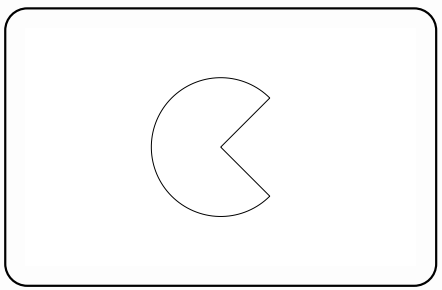
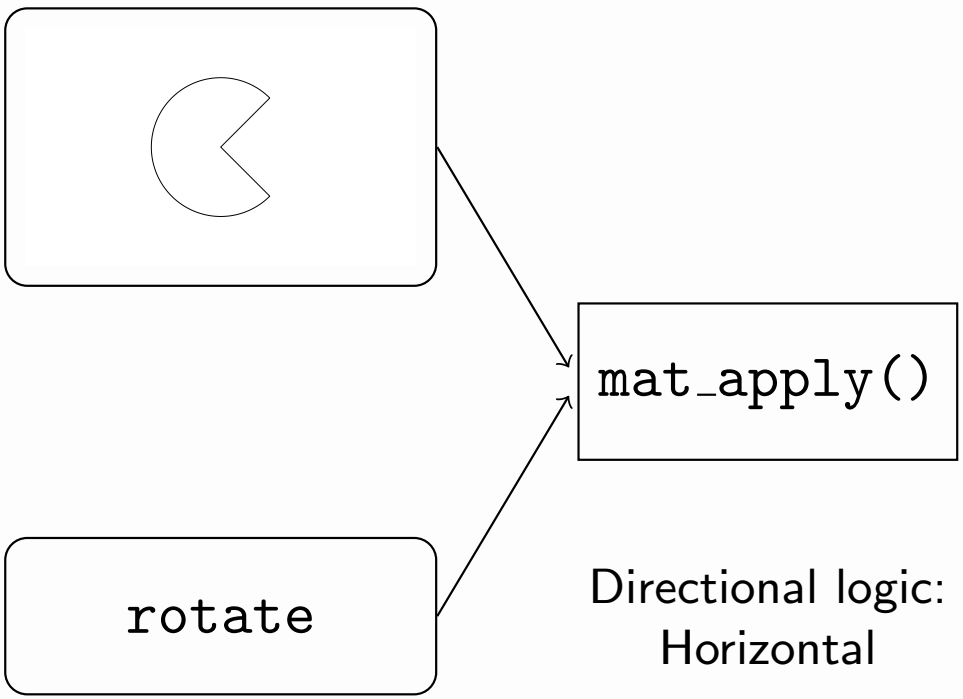


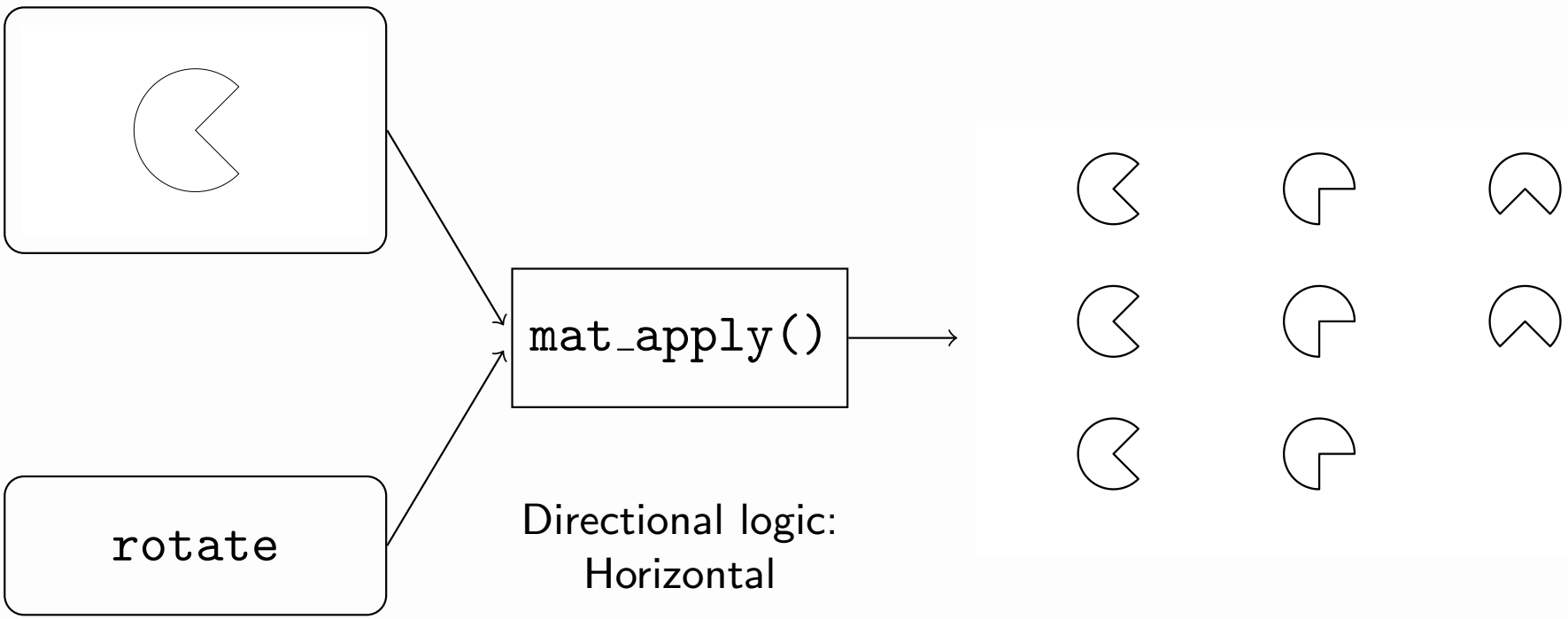




`rotate`




Directional logic:
Horizontal


mat_apply()
rotate
Directional logic:
Horizontal

# The matRiks architecture: Response options generator

| | | |
|---|---|---|
| Cell1 | Cell2 | Cell3 |
| Cell4 | Cell5 | Cell6 |
| Cell7 | Cell8 | ? |

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Response options generator

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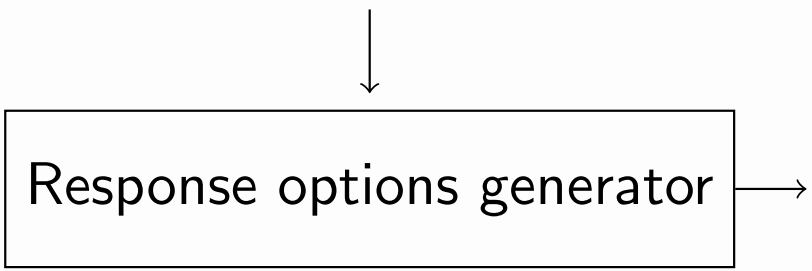
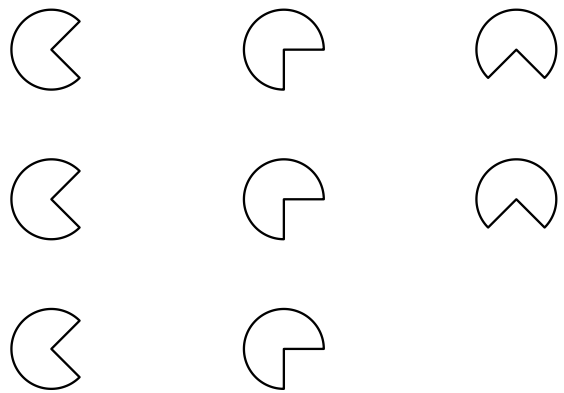
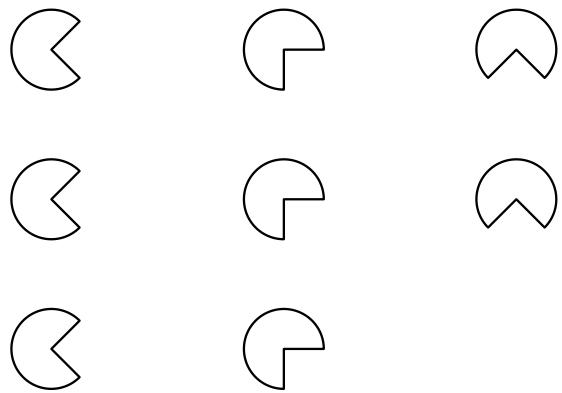


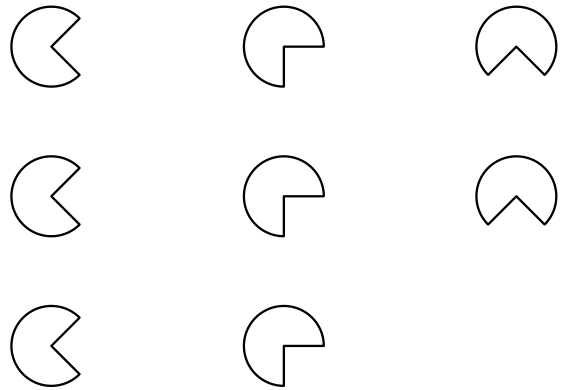

| | |
|---|---|
| Correct | ×1 |
| Repetition | ×3 |
| Incomplete Correlate | ×4 |
| Wrong Principle | ×2 |
| Difference | ×1 |

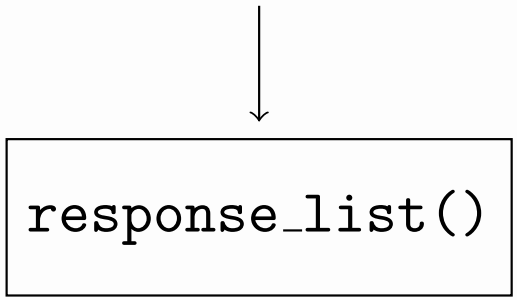


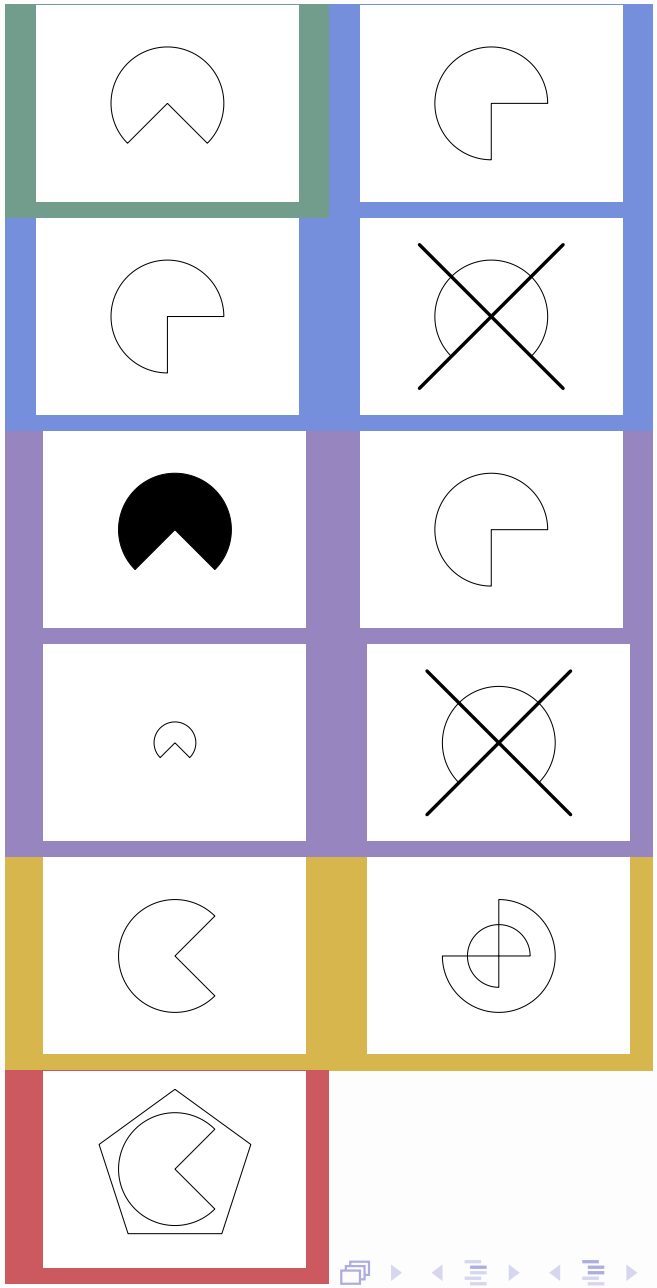




`response_list()`




response_list()



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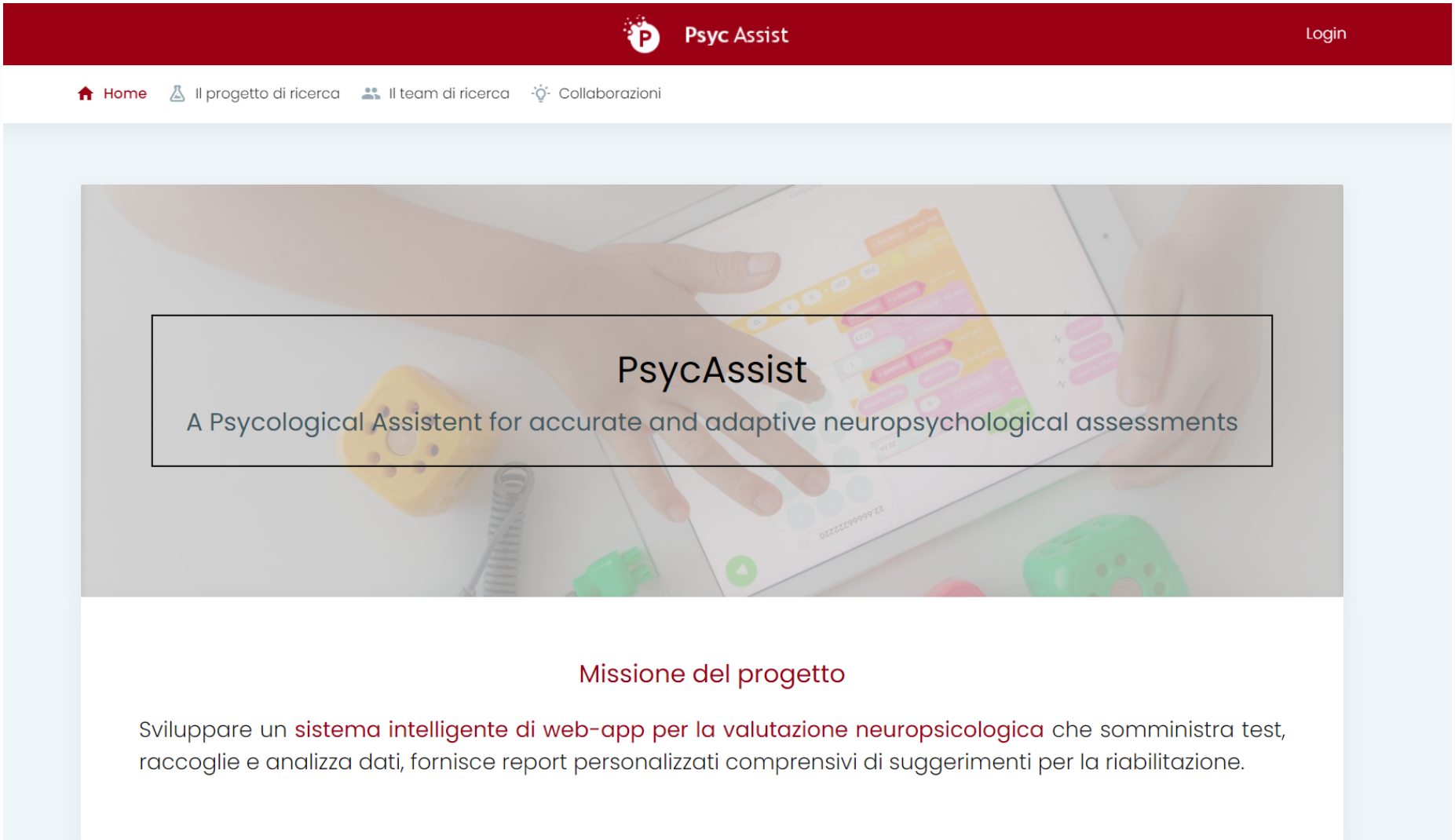
# PsycAssist


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:

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

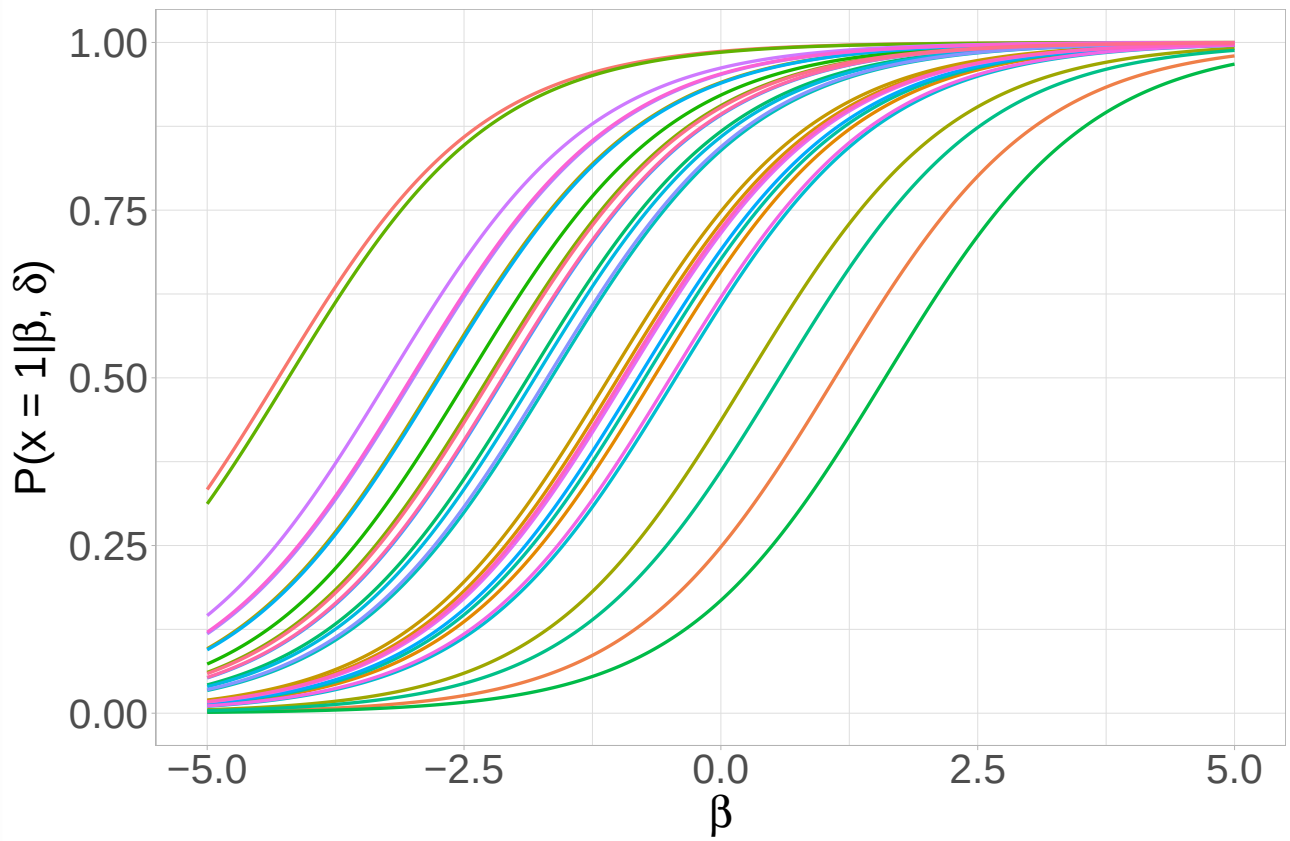
Oufit statistic suggested the underfit of one matrix (item 21) $\rightarrow$ removed and refitted the model

- 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 |



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- Formalization of the matrix generation
- Generate similar but different matrices $\rightarrow$ Equivalent matrices (?)
- Reproducibility of the stimuli
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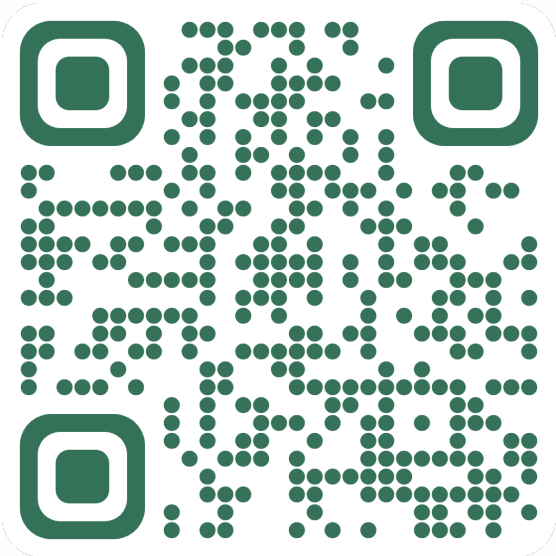
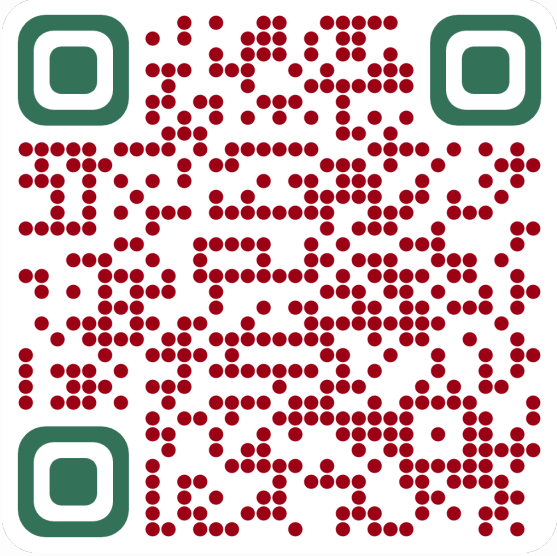
➡ SOON A shiny app

matRiks

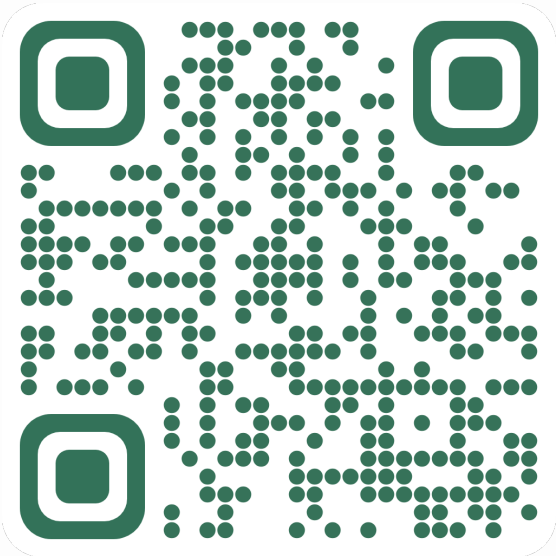


https://github.com/OttaviaE/matRiks

Slides



matRiks



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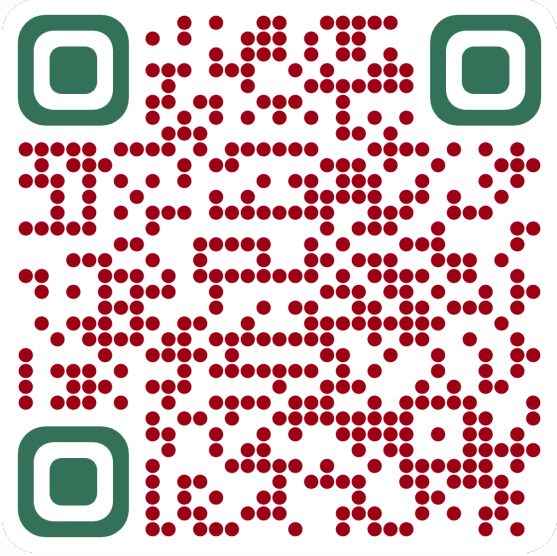
Slides



# Thank you!

ottavia.epifania@unipd.it

useR!