

# Minimum-Residual Factor Analysis

Standalone verified Python analysis

Test: Minimum-Residual Factor Analysis

Design: Two-factor MINRES solution with oblimin rotation, matching a common R psych workflow.

Variables: G1, G2, G3, famrel, freetime, goout

Null hypothesis: The off-diagonal residual objective is not improved by two common factors.

Formula: Minimize  $\sum_{i < j} (r_{ij} - [\Lambda \Lambda^T]_{ij})^2$ , then oblimin rotate.

Source rows: 649

Calculated metrics:

factors: 2

minres\_residual\_sum\_squares: 0.0005363145352556464

optimizer\_evaluations: 24

mean\_communality: 0.5668425200674877

maximum\_loading: 0.980285066663166

Independent reference values:

factors: 2

minres\_residual\_sum\_squares: 0.0005363145352556464

optimizer\_evaluations: 24

mean\_communality: 0.5668425200674877

maximum\_loading: 0.980285066663166

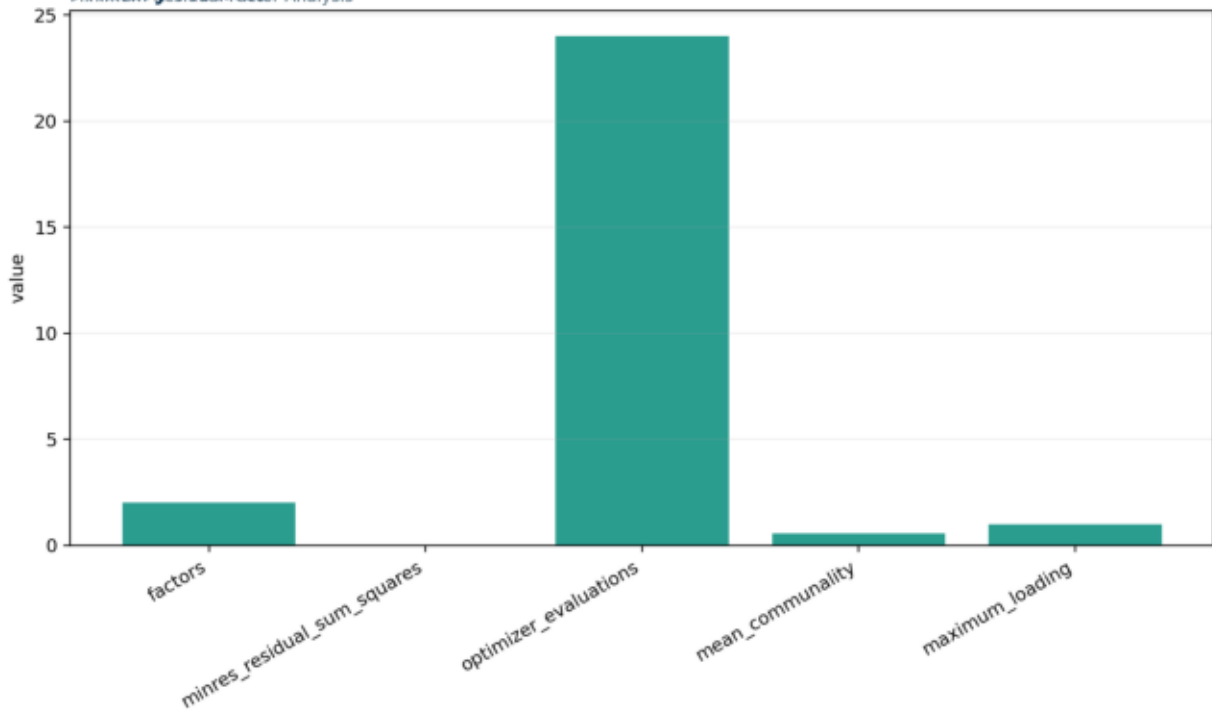
Interpretation:

This R-style workflow minimizes off-diagonal residual correlations.

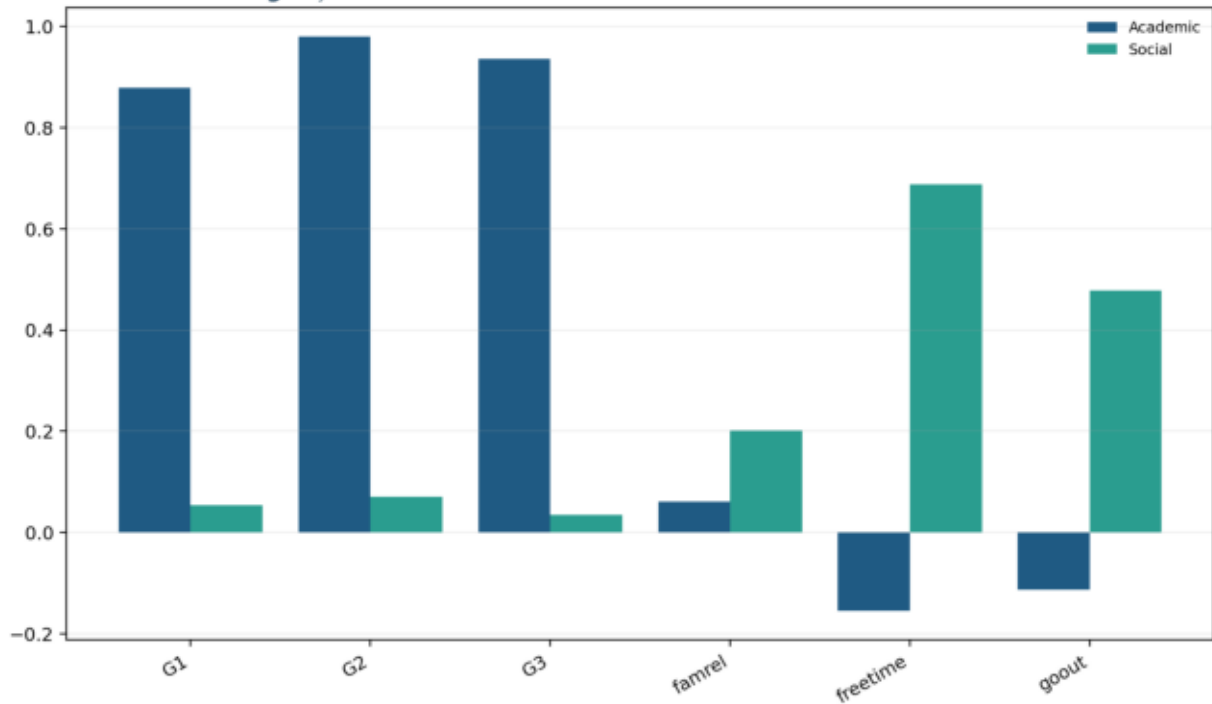
MINRES residual sum of squares=0.000536.

## Primary Metrics

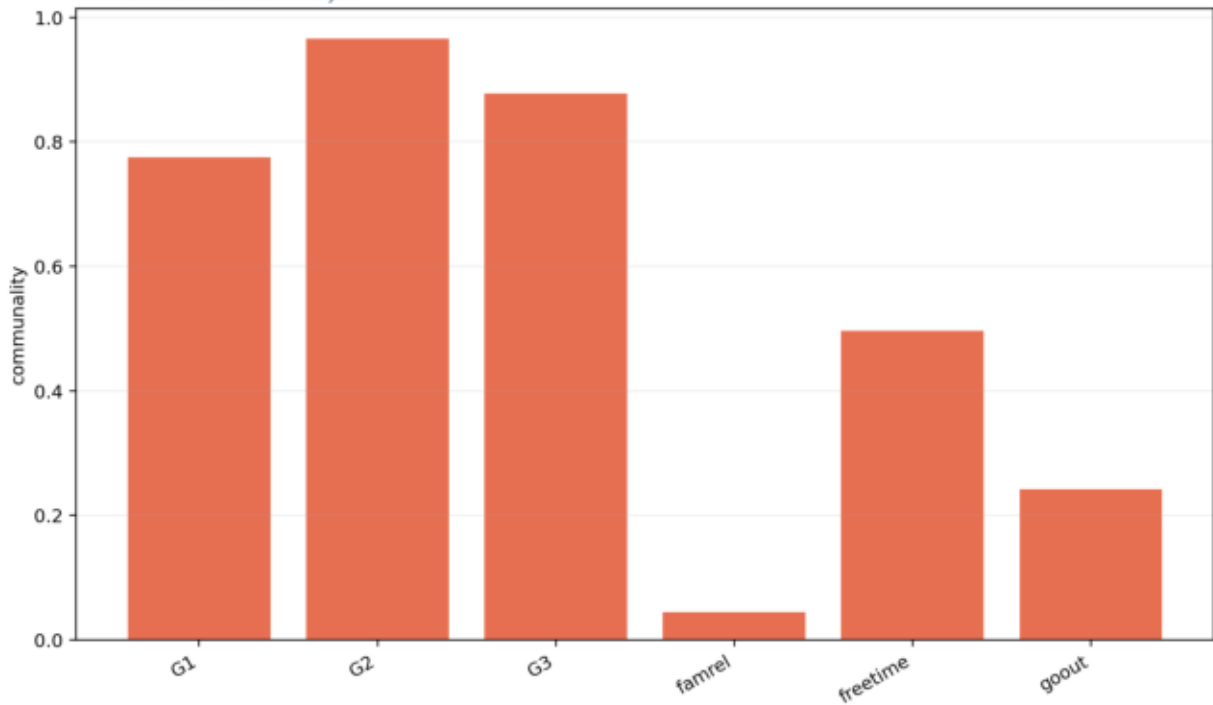
Primary Metrics for Analysis



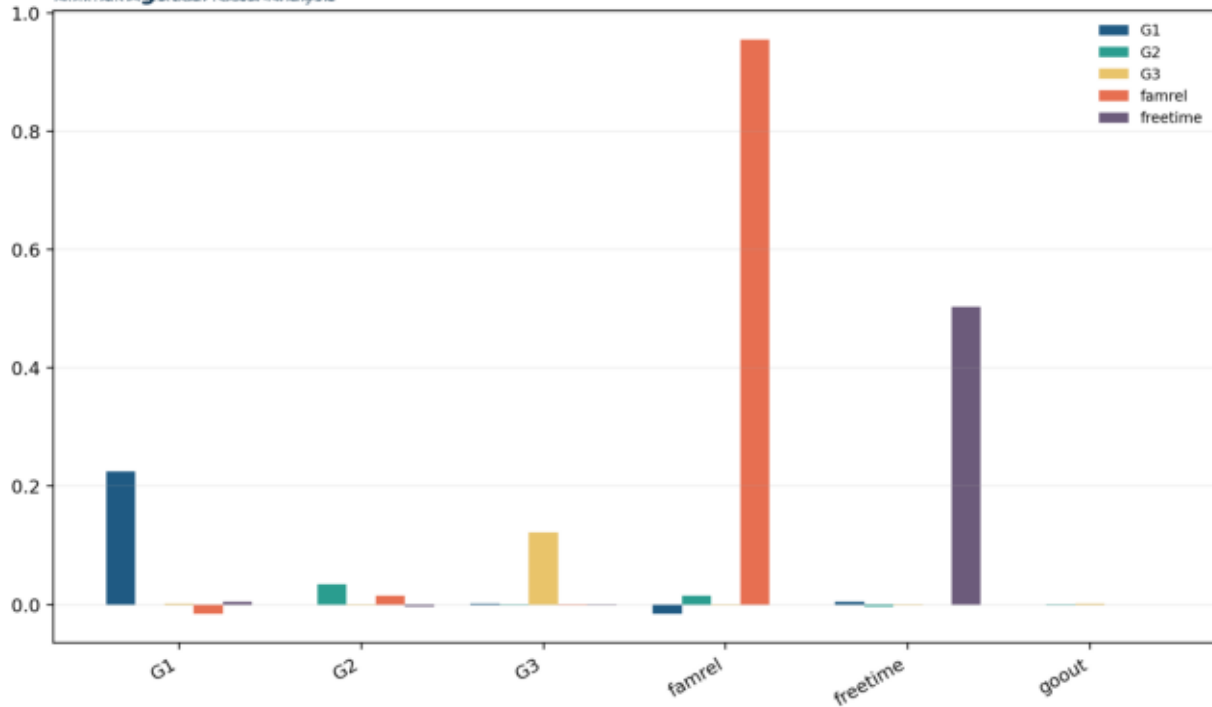
# R Minres Loadings analysis



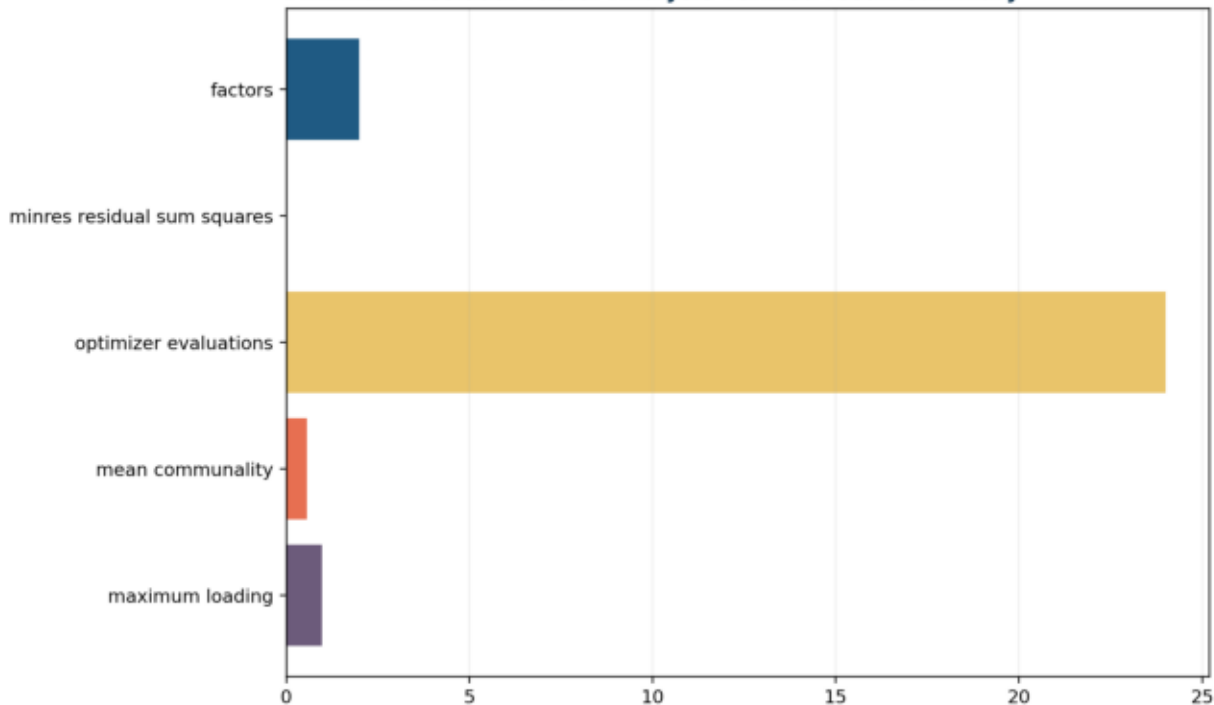
Minres Communalities



Off Diagonal Residuals



Minimum-Residual Factor Analysis verified result summary



# Primary Metrics

| metric                      | value       |
|-----------------------------|-------------|
| factors                     | 2           |
| minres_residual_sum_squares | 0.000536315 |
| optimizer_evaluations       | 24          |
| mean_communality            | 0.566843    |
| maximum_loading             | 0.980285    |

# R Minres Loadings

| item     | Academic  | Social    |
|----------|-----------|-----------|
| G1       | 0.878645  | 0.0538232 |
| G2       | 0.980285  | 0.0703295 |
| G3       | 0.936209  | 0.0343254 |
| famrel   | 0.0613362 | 0.202193  |
| freetime | -0.155005 | 0.687273  |
| goout    | -0.113429 | 0.478213  |

# Minres Communalities

| item     | communality |
|----------|-------------|
| G1       | 0.774915    |
| G2       | 0.965905    |
| G3       | 0.877666    |
| famrel   | 0.0446442   |
| freetime | 0.496371    |
| goout    | 0.241554    |

# Off Diagonal Residuals

| item     | G1           | G2           | G3          | famrel       | freetime     | goout        |
|----------|--------------|--------------|-------------|--------------|--------------|--------------|
| G1       | 0.225085     | -0.000126736 | 0.00194343  | -0.0159809   | 0.0047062    | -0.000127593 |
| G2       | -0.000126736 | 0.034095     | -0.00161825 | 0.0152407    | -0.00306484  | -0.00190878  |
| G3       | 0.00194343   | -0.00161825  | 0.122334    | -0.00100279  | -0.00117913  | 0.00213786   |
| famrel   | -0.0159809   | 0.0152407    | -0.00100279 | 0.955356     | -0.000238802 | -2.75669e-05 |
| freetime | 0.0047062    | -0.00306484  | -0.00117913 | -0.000238802 | 0.503629     | 0.000106657  |
| goout    | -0.000127593 | -0.00190878  | 0.00213786  | -2.75669e-05 | 0.000106657  | 0.758446     |