

# Package ‘MixFrac’

May 7, 2026

**Type** Package

**Title** Fractional Factorial Designs with Alias and Trend-Free Analysis

**Version** 1.0

**Description** Constructs mixed-level and regular fractional factorial designs using coordinate-exchange optimization and automatic generator search. Design quality is evaluated with J2 and balance (H-hat) criteria, alias structures are computed via correlation-based chaining, and deterministic trend-free run orders can be produced following Coster (1993) <[doi:10.1214/aos/1176349410](https://doi.org/10.1214/aos/1176349410)>. Mixed-level design construction follows the NONBPA approach of Pantoja-Pacheco et al. (2021) <[doi:10.3390/math9131455](https://doi.org/10.3390/math9131455)>. Regular fraction identification follows Guo, Simpson and Pignatiello (2007) <[doi:10.1080/00224065.2007.11917691](https://doi.org/10.1080/00224065.2007.11917691)>. Alias structure computation follows Rios-Lira et al.(2021) <[doi:10.3390/math9233053](https://doi.org/10.3390/math9233053)>.

**License** GPL-3

**Encoding** UTF-8

**RoxygenNote** 7.3.3

**Imports** stats, utils

**Suggests** knitr, rmarkdown, testthat (>= 3.0.0)

**VignetteBuilder** knitr

**Config/testthat/edition** 3

**NeedsCompilation** no

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## Contents

generate_ff . . . . .	2
<b>Index</b>	<b>5</b>

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 generate\_ff

 Generate Mixed-Level or Regular Fractional Factorial Designs
 

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### Description

generate\_ff() constructs mixed-level fractional factorial designs or, when all factors share the same number of levels  $s$ , automatically searches for a regular  $s^{k-p}$  fractional factorial using generator relations.

#' The function performs:

- **Part 1:** Design construction (regular or mixed-level)
- **Part 2:** Design diagnostics: balance (Hhat), J2, GBM, alias chains, and strong confounding summary
- **Part 3 (optional):** Deterministic trend-free run order based on Coster (1993)

Output printing can be controlled via the parts argument.

### Usage

```
generate_ff(
  levels_spec,
  n_runs,
  max_iter = 100,
  a = 1,
  b = 1,
  max_int_order = 3,
  alias_min_abs_corr = 0.9,
  tf = FALSE,
  parts = c(1, 2, 3),
  verbose = TRUE
)
```

### Arguments

levels_spec	A numeric vector such as c(2, 3, 4) (levels per factor), or a named list of level labels (e.g. list(A = 1:2, B = 1:3, C = 1:4)).
n_runs	Number of experimental runs required.
max_iter	Maximum number of iterations for coordinate exchange or unique-subset improvement (default: 100).
a	Weight for the J2 near-orthogonality criterion.
b	Weight for the Hhat balance criterion.
max_int_order	Highest-order interaction used when building model matrices for alias calculations. Default is 3.
alias_min_abs_corr	Minimum absolute correlation required for a pair of model terms to appear in the strong confounding summary table.

tf	Logical. When TRUE, computes a trend-free run order (Part 3) based on deterministic pairwise swapping.
parts	Integer vector selecting which sections to print: <ul style="list-style-type: none"> <li>• 1 -&gt; Part 1: Design</li> <li>• 2 -&gt; Part 2: Properties &amp; alias</li> <li>• 3 -&gt; Part 3: Trend-free order</li> </ul> To print all: parts = c(1, 2, 3) (default).
verbose	Logical. When TRUE, prints results. When FALSE, performs all computations silently.

## Details

### Automatic Regular Fractional Factorial Detection:

When all factors have the same number of levels  $s$ , and when  $n\_runs = s^{k-p}$ , the function attempts to find a regular  $s^{k-p}$  fraction via a heuristic generator search inspired by Guo et al. (2007). The objective minimized is:

The objective function minimized is  $Z = a * J2 + b * Hhat$ .

If no acceptable generator set is found, the algorithm reverts to a mixed-level design strategy.

### Mixed-Level Fractional Factorials:

Mixed-level designs are constructed using the Pantoja-Pacheco et al. (2021) NONBPA skeleton for nonmultiple levels, followed by a Guo-style coordinate exchange improvement on the  $Z$ -criterion.

### Alias Structure (Rios-Lira et al., 2021):

Alias relationships are computed from the correlation matrix of the model matrix (main effects + interactions). Chains are built by selecting the pair of terms with the highest absolute correlation, choosing the lower-order term as the chain leader.

### Trend-Free Run Order (Coster, 1993):

When tf = TRUE, a deterministic pairwise-swap algorithm produces a run order orthogonal to polynomial time trends (linear by default).

## Value

A list containing:

- design\_int -> integer-coded design
- design\_labels -> decoded factor levels
- level\_maps -> internal mapping of coded levels
- Hhat -> balance measure
- J2hat -> near-orthogonality measure
- GBM -> general balance metric
- gbm\_resolution -> smallest order with imbalance
- model\_matrix -> model matrix with interactions

- corr\_matrix -> correlation matrix
- alias\_chains -> alias chain structure
- alias\_summary -> strong confounding pairs
- trend\_free\_result -> (if tf = TRUE) run order, reordered design, and final trend objective

Returned invisibly unless assigned.

## References

- Guo, Y., Simpson, J. R., & Pignatiello, J. J. (2007). *Construction of Efficient Mixed-Level Fractional Factorial Designs*. Journal of Quality Technology, 39(3), 241-257. doi:[10.1080/00224065.2007.11917691](https://doi.org/10.1080/00224065.2007.11917691)
- Pantoja-Pacheco, Y. V. et al. (2021). *One Note for Fractionation and Increase for Mixed-Level Designs When the Levels Are Not Multiple*. Mathematics, 9(13), 1455. doi:[10.3390/math9131455](https://doi.org/10.3390/math9131455)
- Rios-Lira, A. J. et al. (2021). *Alias Structures and Sequential Experimentation for Mixed-Level Designs*. Mathematics, 9(23), 3053. doi:[10.3390/math9233053](https://doi.org/10.3390/math9233053)
- Coster, D. C. (1993). *Trend-Free Run Orders of Mixed-Level Fractional Factorial Designs*. Annals of Statistics, 21(4), 2072-2086. doi:[10.1214/aos/1176349410](https://doi.org/10.1214/aos/1176349410)

## Examples

```
# Mixed-level design (2 x 3 x 4), 12 runs, all parts printed
generate_ff(c(2,3,4), 12, tf = TRUE)

# Only Part 1 (design)
generate_ff(c(2,3,4), 12, parts = 1, tf = FALSE)

# Parts 1 and 2 only
generate_ff(c(2,3,4), 12, parts = c(1,2), tf = FALSE)

# Only Part 3 (trend-free run order)
generate_ff(c(2,3,4), 12, parts = 3, tf = TRUE)
```

# Index

`generate_ff`, [2](#)