Package: blockedFF (via r-universe)

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Type Package

Title Generation of Blocked Fractional Factorial Designs (Two-Level and Three-Level)

Version 0.1.0

Description Provides computational tools to generate efficient blocked and unblocked fractional factorial designs for two-level and three-level factors using the generalized Minimum Aberration (MA) criterion and related optimization algorithms. Methodological foundations include the general theory of minimum aberration as described by Cheng and Tang (2005) <doi:10.1214/009053604000001228>, and the catalogue of three-level regular fractional factorial designs developed by Xu (2005) <doi:10.1007/s00184-005-0408-x>. The main functions dol2() and dol3() generate blocked two-level and three-level fractional factorial designs, respectively, using beam search, optimization-based ranking, confounding assessment, and structured output suitable for complete factorial situations.

License GPL-3

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`dol2` *Generate efficient 2-Level Fractional Factorial Designs Using Beam Search*

Description

This function constructs efficient 2-level unblocked and blocked fractional factorial designs using a beam–search–based generator selection algorithm. It evaluates candidate generators using proxy criteria (K3, K4) and returns the top-ranked designs along with generators, scores, alias structure, and blocked designs.

Usage

```
dol2(n, k, max_results = 20, beam_width = 3000, verbose = TRUE)
```

Arguments

`n`	Integer. Total number of factors (base factors + generators).
`k`	Integer. Number of dependent generator columns to add i.e. size of the fraction. The resulting design has `r = n - k` base factors.
`max_results`	Integer. Maximum number of final best-ranked designs to return. Default is 20.
`beam_width`	Integer. Maximum beam width used in beam search. Default is 3000.
`verbose`	Logical. If `TRUE`, prints detailed output for every ranked design, including alias structure and blocked design. Default is TRUE.

Details

The function automatically:

- enumerates all possible generator masks,
- performs canonical ordering to avoid duplicates,
- evaluates designs using moment-based proxy criteria,
- selects best designs based on beam search,
- prints clean summaries (rank, design matrix, aliasing, blocks),
- returns a structured list of final designs.

The function internally uses:

- binary encoding of columns for canonical keys,
- moment-based proxies K3 and K4,

- mask enumeration for generator creation,
- alias structure detection for main and 2-factor effects,
- automatic block generator selection (2-level).

The generated output provides experimenters with statistically efficient two-level fractional factorial designs that are well suited for both industrial and agricultural research. By reducing the total number of experimental runs while preserving the ability to estimate key main effects and low-order interactions, these designs offer a resource-efficient framework for screening factors, optimizing processes, and evaluating system performance under practical field or laboratory constraints.

Value

A list (invisible) of the best-ranked designs. Each element contains:

- `generators_str`: Defining contrast used for generation of design,
- `design`: final design matrix with renamed factor labels,
- `score`: proxy measures (K3, K4),
- `key`: canonical key used for uniqueness.

References

Dash, S., Parsad, R. and Gupta, V. K. (2013). Row–column Designs for 2^n factorial 2-Colour Microarray Experiments for Estimation of Main Effects and Two-Factor Interactions with Orthogonal Parameterization. *Agricultural Research*, 2(2), 172–182.

National Bureau of Standards (1957). *Fractional Factorial Experiment Designs for Factors at Two Levels*. Applied Mathematics Series 48. US Government Printing Office, Washington DC.

Examples

```
# Generate 2-level fractional factorial designs:
res <- dol2(n = 5, k = 2, max_results = 5, beam_width = 3000, verbose = TRUE)

# Access first ranked design
res[[1]]$design
res[[1]]$generators_str
```

`dol3` *Generate efficient 3-Level Fractional Factorial Designs Using Beam Search*

Description

This function constructs efficient 3-level unblocked and blocked fractional factorial designs using an iterative beam-search generator selection algorithm.

Usage

```
dol3(
  n,
  k,
  max_results = 20,
  top_k_block = 3,
  beam_width = 3000,
  verbose = TRUE,
  time_limit = 600
)
```

Arguments

n	Integer. Total number of factors (base + generated).
k	Integer. Number of dependent generator columns to add i.e. size of fraction. The number of base factors is r = n − k.
max_results	Integer. Maximum number of final best-ranked designs returned. Default: 20.
top_k_block	Integer. Number of top block generators to consider when automatically selecting block structures. Default: 3.
beam_width	Integer. Maximum beam width used during the beam search. Default: 3000.
verbose	Logical. If TRUE, prints ranked designs, WL patterns, alias structures, and blocked designs. Default: TRUE.
time_limit	Numeric. Maximum elapsed time (seconds) allowed for the beam-search expansion. Default: 600.

Details

It evaluates candidate generators using moment-based proxy criteria (A_3, A_4, A_5, A_6) and returns the best-ranked designs along with:

- generator coefficient vectors,
- canonical ternary design keys,
- full design matrices,
- word-length patterns,
- alias structure (main + 2-factor),
- automatically determined block structures.

This is the 3-level analogue of `dol2()`, supporting generation of 3-level fractional factorial design generation.

Internally, `dol3()` performs:

- ternary (0/1/2) grid generation for base factors,
- dynamic enumeration of canonical generator coefficient vectors,
- computation of moment based K statistics and $A_3 - A_6$,
- canonical design key generation to avoid duplication,

- beam-search pruning with user-specified width,
- automatic selection of efficient 3-level block generators.

The generated designs are well suited for industrial, agricultural, and scientific investigations that demand high-resolution three-level fractional factorial structures with optional blocking. These designs efficiently accommodate multi-level factors, enable precise estimation of main effects and critical interaction terms, and offer flexibility for managing heterogeneity through block formation. As a result, they provide a robust and resource-efficient framework for complex experimental systems conducted in field or laboratory settings.

Value

A list (invisible) of the best-ranked 3-level fractional factorial designs.

Each list element contains:

- `generators`: list of generator coefficient vectors,
- `generators_str`: Defining contrast expressions,
- `design`: final design matrix with renamed factor levels,
- `A`: word-length pattern (A_3, A_4, A_5, A_6).

When `verbose = TRUE`, the function additionally prints:

- canonical generator expressions,
- design matrix,
- alias structure (main, 2-factor interactions),
- automatically generated blocked design with confounding summary.

References

Xu, H. (2005). A catalogue of three-level regular fractional factorial designs. *Metrika*, 62, 259-281.

Examples

```
# Generate a 3-level fractional factorial design:
res3 <- dol3(n = 5, k = 2, max_results = 3, verbose = TRUE)

# View the best-ranked design:
res3[[1]]$design
res3[[1]]$generators_str
res3[[1]]$A   # Word length pattern A3-A6
```

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