Package: baskoptr (via r-universe)

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Title Utility-Based Optimization for Basket Trial Designs

Version 1.0.4

Description A unified framework for optimizing basket trial designs. To this end, the package supplies several utility functions and also a function for executing optimization algorithms on basket trial designs. The considered utility functions are discussed in Sauer et al. (2025) <doi:10.1371/journal.pone.0323097>.

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Imports baskwrap (>= 1.0.1), future.apply

Suggests optimizr (>= 1.0.0), baskexact (>= 1.0.0), testthat (>= 3.0.0), progressr, basksim (>= 2.0.0)

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Contents

`append_details` *Internal helper function: Append and set elements of a details list*

Description

`append_details` takes the element `details[["index"]]` and appends it with the list `further`. `set_details` takes the element `details[["index"]]` and sets it to `value`.

Usage

```
append_details(details, index, further)

set_details(details, index, value)
```

Arguments

`details`	A list of details to be requested from `baskwrap::get_details.fujikawa_x` (will be supplied to the function as the `which_details` argument).
`index`	Indicates which element of `details` should be appended.
`further`	A list of further parameters to be appended.
`value`	A character string, `details[[index]]` will be assigned `value`.

Value

The updated list of `details`.

`epsilon_extreme` *Extreme borrowing cutoffs for borrowing in Fujikawa's design*

Description

Calculate the extreme borrowing cutoffs for the tuning parameters τ and ϵ in Fujikawa's basket trial design.

Usage

```
epsilon_extreme(design, tau, detail_params)

tau_extreme(design, epsilon, detail_params)
```

Arguments

`design`	An object of class `fujikawa` created by the function `baskwrap::setup_fujikawa_x` or `basksim::setup_fujikawa`.
`tau`	The optimization parameter τ of Fujikawa's basket trial design.
`detail_params`	A named list of parameters containing per-stratum sizes `n` and the base of the logarithm for calculating Jensen-Shannon divergence `logbase`.
`epsilon`	The optimization parameter ε of Fujikawa's basket trial design.

Details

The weights for the borrowing posterior in Fujikawa's design are calculated as

$$\omega_{ij} = \mathbf{1}(\tilde{\omega}_{ij}^{\varepsilon} > \tau) \cdot \tilde{\omega}_{ij}^{\varepsilon}$$

with $\tau \in [0, 1]$, $\varepsilon \geq 0$, and $\tilde{\omega}_{ij} = 1 - JS(\text{Beta}_i^{\text{post}}, \text{Beta}_j^{\text{post}})$. Here, $JS(\cdot, \cdot)$ is the Jensen-Shannon divergence, and

$$\text{Beta}_i^{\text{post}} = \text{Beta}(a_i + r_i, b_i + n_i - r_i)$$

is the beta-binomial conjugated posterior distribution in the i-th stratum for prior Beta parameters a_i an b_i, number of responses r_i and number of patients n_i. In particular for

$$\tilde{\omega}_{ij}^{\varepsilon} \leq \tau,$$

borrowing will only take place for baskets with completely identical response rates. We call this boundary the *extreme borrowing cutoff*. The functions `epsilon_extreme` and `tau_extreme` calculate the extreme borrowing cutoffs $\tau_{\text{extreme}}(\varepsilon)$ and $\varepsilon_{\text{extreme}}(\tau)$, which are the boundaries of

$$\tau \geq (\max_{r_k \neq r_l} \tilde{\omega}_{kl})^{\varepsilon}$$

and

$$\varepsilon \geq \log_{\max_{r_k \neq r_l} \tilde{\omega}_{kl}}(\tau).$$

The extreme borrowing cutoffs depend neither on `p0` nor on `p1`. They only depend on the number of baskets `k` and the number of patients per basket `n`. The extreme borrowing cutoff is discussed in Sauer et al. (2025).

Value

A numeric, the extreme borrowing cutoff for ε.

References

Sauer LD, Ritz A, Kieser M. Utility-based optimization of Fujikawa's basket trial design – Pre-specified protocol of a comparison study. PLOS ONE. 2025;20(5):e0323097. doi:10.1371/journal.pone.0323097

Examples

```
design <- basksim::setup_fujikawa(k = 3,
                                  shape1 = 1,
                                  shape2 = 1,
                                  p0 = 0.2)
detail_params <- list(n = 20,
                      logbase = exp(1))
epsilon_extreme(design, tau = 0.5, detail_params)
tau_extreme(design, epsilon = 2, detail_params)
```

---

get_details_for_two_scenarios

Internal helper function: Get details for two response scenarios

---

Description

Internal helper function: Get details for two response scenarios

Usage

```
get_details_for_two_scenarios(
  design,
  x,
  detail_params,
  p1,
  p2,
  which_details_list = NULL
)
```

Arguments

`design`	An object of class `fujikawa` created by the function `baskwrap::setup_fujikawa_x` or `basksim::setup_fujikawa`.
`x`	A named list, the design's tuning parameters to be optimized.
`detail_params`	A named list of parameters that need to be supplied to `get_details()`. If `p1` exists, `detail_params$p1` is replaced by `p1` for calculating power resp. ECD and by `p2` for calculating FWER.

p1 A numeric, response scenario for calculating power resp. ECD. This can also be left NULL, then the function goes looking in detail_params$p1.

p2 A numeric, response scenario for calculating FWER, default is the global null scenario.

which_details_list
A list of two lists, which_details_list[["p1"]] and which_details_list[["p2"]], containing the details which are to be requested for p1 and p2, respectively. NULL means that all will be requested.

Value

A list of two lists containing return values of get_details calls.

---

get_p1s *Generate an array of possible outcome scenarios*

Description

This functions generates an array of possible outcome scenarios. Each row of the array is a scenario vector. The array starts with k inactive baskets and 0 active baskets and then increments in steps of by up to k active baskets (or the next smaller multiple of by).

Usage

```
get_p1s(k, p0, p1, by = 1)
```

Arguments

k The number of baskets.

p0 A common probability under the null hypothesis.

p1 A numeric, the true response probability for the active baskets

by A numeric, increment of the scenario sequence, default: 1.

Value

A numeric array.

Examples

```
p1s <- get_p1s(k = 3, p0 = 0.2, p1 = 0.5)
```

get_scenarios *Generate a scenario of possible outcomes*

Description

A wrapper of `get_p1s()` that also returns the input values `k` and `p0` as part of a list.

Usage

```
get_scenarios(k, p0, p1, by = 1)
```

Arguments

`k`	The number of baskets.
`p0`	A common probability under the null hypothesis.
`p1`	A numeric, the true response probability for the active baskets
`by`	A numeric, increment of the scenario sequence, default: 1.

Value

A list with components `k`, `p0` and `p1s`, where `p1s` is generated by the the function `get_p1s`.

Examples

```
scenario <- get_scenarios(k = 3, p0 = 0.2, p1 = 0.5)
```

get_trace_info *Internal helper function: Decide whether to record a trace and what path to use*

Description

Internal helper function: Decide whether to record a trace and what path to use

Usage

```
get_trace_info(trace, type = "trace")
```

Arguments

`trace`	A parameter that can be `FALSE`, `TRUE` or a file path.
`type`	A character that designates the name of the input.

Value

A list with components `rec` and `path`.

io_val_p1 *Internal helper function: Input validation for p1*

Description

Returns `detail_params` with checked element `detail_params$p1 <- p1`, depending on whether `p1` is not `NULL` or `detail_params$p1` is not `NULL`. Returns an error message if both are NULL.

Usage

```
io_val_p1(detail_params, p1)
```

Arguments

`detail_params`	A named list of parameters that need to be supplied to `get_details()`. If `p1` exists, `detail_params$p1` is replaced by `p1` for calculating power resp. ECD and by `p2` for calculating FWER.
`p1`	A numeric, response scenario for calculating power resp. ECD. This can also be left `NULL`, then the function goes looking in `detail_params$p1`.

Value

The updated list of `detail_params`.

opt_design_gen *Optimize a Basket Trial Design*

Description

Optimize the parameters of a basket trial design using a utility-based approach with a simulation algorithm of your choice.

Usage

```
opt_design_gen(
  design,
  utility,
  algorithm,
  detail_params,
  utility_params,
  algorithm_params,
  x_names = NULL,
  fn_name = "fn",
  trace = FALSE,
  trace_options = list(robust = FALSE),
```

```
  format_result = NULL,
  final_details = FALSE,
  final_details_utility_params = utility_params,
  progress_bar = NULL
)
```

Arguments

design	An object of class fujikawa created by the function baskwrap::setup_fujikawa_x or basksim::setup_fujikawa.
utility	A function returning the utility of a parameter combination x of the form utility(design, x, detail_params, ...), where ... may further parameters to be supplied to the utility.
algorithm	A function returning the optimization algorithm's results, should have the form algorithm(fn, ...), where fn is the function to be optimized and ... may be further parameters of the optimization algorithm.
detail_params	A named list of parameters that need to be supplied to get_details().
utility_params	A named list of further parameters that need to be supplied to the utility function.
algorithm_params	A named list of further parameters that need to be supplied to the optimization algorithm.
x_names	A character vector containing the names of the utility functions tuning parameters, automatically retrieved from algorithm_params$par or algorithm_params$lower if either is present. Default is NULL.
fn_name	The name of the function argument of algorithm. The default is "fn".
trace	A logical or a character string, should the trace of the optimization algorithm be recorded (utility values, parameters vectors, and random number seeds)? Default is FALSE. If TRUE, recording is done by dynamic appending of a data frame (which may not be very efficient). If trace is a character vector specifying a file path (ending with ".RDS"), the trace will be dynamically saved to that RDS file. Some optimization algorithms automatically return their trace. In that case, you can switch off using trace = FALSE (or "" or NULL) and request the trace directly from your algorithm using algorith_params.
trace_options	A list, if trace_options = list(robust = TRUE), a robust recording method for saving the optimization steps is used that works well with parallelized algorithms. Caveat: the robust version is not sorted in chronological order.
format_result	(Optional:) A function function(res) for formatting the final output of the optimization algorithm. If you want final_details = TRUE, then the formatted result must have a non-null element res$par containing the optimal parameters.
final_details	A logical, if TRUE, the function runs the utility function one more time on the optimization result and returns the output of the implicit call to baskwrap::get_details() as attr(, "final_details") and the result of the repeated utility function call as attr(, "final_res_repeated"). The latter should be identical to the result for deterministic calculations, but may differ for stochastic calculations.

`final_details_utility_params`
: A list, only takes effect if `final_details==TRUE`. This last run of the utility function will use these list of parameters instead of `utility_params`. However, the default is `final_details_utility_params = utility_params`.

`progress_bar`
: Do you want a progress bar? This argument either takes a numeric containing the number of steps or a `progressr::progressor()`. Only works if `trace` is activated. The number of steps is proportional to the number of algorithm iterations, but the exact number depends on the algorithm's implementation.

Value

a list consisting of the algorithm's output (usually the optimal parameter vector and the resulting optimal utility value and some meta information). If `trace == TRUE`, the trace of the optimization algorithm can be found in the `[["trace"]]` entry of the list. (If the algorithm function also outputs a trace, this will be saved in an additional `[["trace_alg"]]` entry.)

Examples

```
# Optimizing a three-basket trial design using Fujikawa's beta-binomial
# sharing approach
design <- baskwrap::setup_fujikawa_x(k = 3, shape1 = 1, shape2 = 1,
                                     p0 = 0.2, backend = "exact")
detail_params <- list(p1 = c(0.5, 0.2, 0.2),
                                    n = 20,
                                    weight_fun = baskwrap::weights_jsd,
                                    logbase = exp(1))
utility_params <- list(penalty = 1, thresh = 0.1)
# Bounded simulated annealing with progress bar
progressr::handlers(global = TRUE)
opt_design_gen(design = design,
               utility = u_ewp,
               algorithm = optimizr::simann,
               detail_params = detail_params,
               utility_params = utility_params,
               algorithm_params = list(par = c(lambda = 0.99,
                                               epsilon = 2,
                                               tau = 0.5),
                                       lower = c(lambda = 0.001,
                                                 epsilon = 1,
                                                 tau = 0.001),
                                       upper = c(lambda = 0.999,
                                                 epsilon = 10,
                                                 tau = 0.999),
                                       control = list(maxit = 10,
                                                      temp = 10,
                                                      fnscale = -1)),
                                                      trace = TRUE,
                progress_bar = 10 + 2)
```

params_main *List of parameters used across the package*

Description

List of parameters used across the package

Arguments

design	An object of class fujikawa created by the function baskwrap::setup_fujikawa_x or basksim::setup_fujikawa.
x	A named list, the design's tuning parameters to be optimized.
detail_params	A named list of parameters that need to be supplied to get_details().
report_details	A logical, if TRUE, the function returns the output of the implicit call to baskwrap::get_details() as attr(, "details").

params_utility_caller *List of parameters used for functions calling utility functions*

Description

List of parameters used for functions calling utility functions

Arguments

utility	A function returning the utility of a parameter combination x of the form utility(design, x, detail_params, ...), where ... may further parameters to be supplied to the utility.
utility_params	A named list of further parameters that need to be supplied to the utility function.

u_2ewp *Utility functions: Two-level power-error combination functions*

Description

These utility functions combine rewarding power and penalizing TOER by subtracting TOER from power. In addition, unacceptably high FWER above a certain threshold receives harsher penalty.

Usage

```
u_2ewp(
  design,
  x,
  detail_params,
  p1 = NULL,
  penalty1,
  penalty2,
  threshold,
  report_details = FALSE
)

u_2pow(
  design,
  x,
  detail_params,
  p1 = NULL,
  penalty1,
  penalty2,
  threshold,
  report_details = FALSE
)
```

Arguments

design	An object of class fujikawa created by the function baskwrap::setup_fujikawa_x or basksim::setup_fujikawa.
x	A named list, the design's tuning parameters to be optimized.
detail_params	A named list of parameters that need to be supplied to get_details().
p1	A numeric, response scenario for calculating power and error rate.
penalty1	A numeric, penalty1 is the penalty for low FWER,
penalty2	A numeric, penalty1 + penalty2 is the penalty for high FWER.
threshold	A numeric, for high FWER above this threshold we impose a harsher penalty.
report_details	A logical, if TRUE, the function returns the output of the implicit call to baskwrap::get_details() as attr(, "details").

Details

The utility function u_{2ewp} is defined as

$$u_{\text{2ewp}}(\boldsymbol{\phi}, \mathbf{p}) = \text{ewp}(\boldsymbol{\phi}, \mathbf{p}) - (\xi_1 \text{fwer}(\boldsymbol{\phi}, \mathbf{p}) + \xi_2(\text{fwer}(\boldsymbol{\phi}, \mathbf{p}) - \eta)\mathbf{1}(\text{fwer}(\boldsymbol{\phi}, \mathbf{p}) - \eta)) \,,$$

where $\eta \in [0, 1]$ is a threshold for imposing harsher FWER penalty.

The utility function u_{2pow} is defined analogously as

$$u_{\text{2pow}}(\boldsymbol{\phi}, \mathbf{p}) = \sum_{i \in R} \text{pow}_i(\boldsymbol{\phi}, \mathbf{p}) - \sum_{j \in R^c} (\xi_1 \text{toer}_j(\boldsymbol{\phi}, \mathbf{p}) + \xi_2(\text{toer}_j(\boldsymbol{\phi}, \mathbf{p}) - \eta)\mathbf{1}(\text{toer}_j(\boldsymbol{\phi}, \mathbf{p}) - \eta)) \,,$$

where R and R^c are the sets of active and inactive strata, respectively.

The (averaged) $u_{2\text{pow}}$ is defined in Jiang et al. (2021).

Value

A numeric, the parameter combination's utility.

References

Jiang L, Nie L, Yan F, Yuan Y. Optimal Bayesian hierarchical model to accelerate the development of tissue-agnostic drugs and basket trials. Contemporary Clinical Trials. 2021;107:106460. doi:10.1016/j.cct.2021.106460

Examples

```
design <- baskwrap::setup_fujikawa_x(k = 3, shape1 = 1, shape2 = 1,
                                     p0 = 0.2, backend = "exact")
u_2ewp(design,
       x = list(lambda = 0.99, epsilon = 2, tau = 0.5),
       detail_params = list(p1 = c(0.5, 0.2, 0.2),
                            n = 20,
                            weight_fun = baskwrap::weights_jsd,
                            logbase = exp(1)),
       penalty1 = 1, penalty2 = 2,
       threshold = 0.1)
u_2pow(design,
       x = list(lambda = 0.99, epsilon = 2, tau = 0.5),
       detail_params = list(p1 = c(0.5, 0.2, 0.2),
                            n = 20,
                            weight_fun = baskwrap::weights_jsd,
                            logbase = exp(1)),
       penalty1 = 1, penalty2 = 2,
       threshold = 0.1)
```

---

u_avg *Utility function: Scenario-averaged utility function*

Description

For a utility function $u(\cdot, \mathbf{p})$ and a set of true scenarios $\{\mathbf{p}_i, \ldots\}$, calculate the weighted average utility function

$$\bar{u}(x) = \sum_i w_i u(x, \mathbf{p}_i)$$

for a set of weights with $\sum_i w_i = 1$. By default, $w_i = \frac{1}{|\{\mathbf{p}_i, \ldots\}|}$ for all i. The idea of averaging utility functions across a set of scenarios is taken from Jiang et al. (2021).

Usage

```
u_avg(
  design,
  x,
  detail_params,
  utility,
  utility_params,
  p1s,
  weights_u = rep(1/nrow(p1s), nrow(p1s)),
  report_details = FALSE,
  penalty_maxtoer = NULL,
  threshold_maxtoer = NULL,
  use_future = FALSE
)
```

Arguments

design	An object of class fujikawa created by the function baskwrap::setup_fujikawa_x or basksim::setup_fujikawa.
x	A named list, the design's tuning parameters to be optimized.
detail_params	A named list of parameters that need to be supplied to get_details(). It must not contain p1, as this is supplied separately.
utility	A function returning the utility of a parameter combination x of the form utility(design, x, detail_params, ...), where ... may further parameters to be supplied to the utility.
utility_params	A named list of further parameters that need to be supplied to the utility function.
p1s	A numeric array in which each row defines a scenario of true response rates under the alternative hypothesis.
weights_u	A numeric vector of weights for calculating the weighted average.
report_details	A logical, if TRUE, the function returns the output of the implicit call to baskwrap::get_details() as attr(, "details").
penalty_maxtoer	A numeric, the penalty for punishing the maximal TOER across all considered scenarios and all strata.
threshold_maxtoer	A numeric, above this threshold maximal TOER is punished by returning -penalty_maxtoer times the maximal TOER. Default is NULL, which means no penalty.
use_future	A logical, should future_apply() instead of apply() be used for calculating the utilities to be averaged over. You must still activate a *future* backend for this option to take any effect, default is FALSE.

Value

A numeric, the parameter combination's utility.

References

Jiang L, Nie L, Yan F, Yuan Y. Optimal Bayesian hierarchical model to accelerate the development of tissue-agnostic drugs and basket trials. Contemporary Clinical Trials. 2021;107:106460. doi:10.1016/j.cct.2021.106460

Examples

```
design <- baskwrap::setup_fujikawa_x(k = 3, shape1 = 1, shape2 = 1,
                                     p0 = 0.2, backend = "exact")
x <- list(lambda = 0.99, epsilon = 2, tau = 0.5)
detail_params <- list(n = 20,
                      weight_fun = baskwrap::weights_jsd,
                      logbase = exp(1))
p1s <- rbind(c(0.2,0.2,0.2), c(0.2,0.2,0.5), c(0.2,0.5,0.5), c(0.5,0.5,0.5))
# Averaging over u_ewp()
u_avg(design,
      x = x,
      detail_params = detail_params,
      utility = u_ewp,
      utility_params = list(penalty = 1, threshold = 0.1),
      p1s = p1s
      )

# Averaging over u_2ewp()
utility_params_2ewp <- list(penalty1 = 1, penalty2 = 2, threshold = 0.1)
u_avg(design,
      x = x,
      detail_params = detail_params,
      utility = u_2ewp,
      utility_params = utility_params_2ewp,
      p1s = p1s
      )
# Punishing maximal TOER in all scenarios and all strata
u_avg(design,
      x = x,
      detail_params = detail_params,
      utility = u_2ewp,
      utility_params = utility_params_2ewp,
      p1s = p1s,
      penalty_maxtoer = 1, threshold_maxtoer = 0.1
      )
```

---

u_bnd *Utility function with boundaries on the parameters*

Description

This function manually implements boundaries for a given utility function `utility`. If the vector `x` lies out of the lower and upper bounds, the function returns `NA_real_`. Else it returns the utility functions value.

Usage

```
u_bnd(
  design,
  x,
  detail_params,
  utility,
  utility_params,
  lower,
  upper,
  report_details = FALSE
)
```

Arguments

design	An object of class fujikawa created by the function baskwrap::setup_fujikawa_x or basksim::setup_fujikawa.
x	A named list, the design's tuning parameters to be optimized.
detail_params	A named list of parameters that need to be supplied to get_details().
utility	A function returning the utility of a parameter combination x of the form utility(design, x, detail_params, ...), where ... may further parameters to be supplied to the utility.
utility_params	A named list of further parameters that need to be supplied to the utility function.
lower	numerical, a vector of lower bounds of the parameters.
upper	numerical, a vector of upper bounds of the parameters.
report_details	A logical, if TRUE, the function returns the output of the implicit call to baskwrap::get_details() as attr(, "details").

Value

A numeric, the parameter combination's utility.

Examples

```
design <- baskwrap::setup_fujikawa_x(k = 3, shape1 = 1, shape2 = 1,
                                     p0 = 0.2, backend = "exact")
lower <- list(lambda = 0, epsilon = 1, tau = 0)
upper <- list(lambda = 1, epsilon = 10, tau = 1)
utility_params <- list(penalty = 1, threshold = 0.1)
detail_params <- list(p1 = c(0.5, 0.2, 0.2),
                      n = 20,
                      weight_fun = baskwrap::weights_jsd,
                      logbase = exp(1))
# Out of bounds
u_bnd(design = design,
      x = list(lambda = 1.3, epsilon = 2, tau = 0.5),
      detail_params = detail_params,
      utility = u_ewp,
      utility_params = utility_params,
```

```
      lower = lower,
      upper = upper)
# Inside bounds, this is the same as u_ewp
x <- list(lambda = 0.99, epsilon = 2, tau = 0.5)
u_bnd(design = design,
      x = x,
      detail_params = detail_params,
      utility = u_ewp,
      utility_params = utility_params,
      lower = lower,
      upper = upper)
u_ewp(design = design,
      x = x,
      detail_params = detail_params, penalty = 1, threshold = 0.1)
```

---

u_ewp *Utility functions: Discontinuous power/ECD functions with type-I error penalty*

Description

These utility functions return experiment-wise power (EWP) or expected number of correct decisions (ECD) if the family-wise error rate (FWER) is low and the negative FWER multiplied by a penalty parameter if the FWER is high.

Usage

```
u_ewp(
  design,
  x,
  detail_params,
  p1 = NULL,
  p2 = rep(design$p0, design$k),
  threshold,
  penalty,
  report_details = FALSE,
  reduce_calculations = ifelse(design$backend == "exact", TRUE, FALSE)
)

u_ecd(
  design,
  x,
  detail_params,
  p1 = NULL,
  p2 = rep(design$p0, design$k),
  penalty,
  threshold,
  report_details = FALSE,
```

```
  reduce_calculations = ifelse(design$backend == "exact", TRUE, FALSE)
)
```

Arguments

design	An object of class fujikawa created by the function baskwrap::setup_fujikawa_x or basksim::setup_fujikawa.
x	A named list, the design's tuning parameters to be optimized.
detail_params	A named list of parameters that need to be supplied to get_details(). If p1 exists, detail_params$p1 is replaced by p1 for calculating power resp. ECD and by p2 for calculating FWER.
p1	A numeric, response scenario for calculating power resp. ECD. This can also be left NULL, then the function goes looking in detail_params$p1.
p2	A numeric, response scenario for calculating FWER, default is the global null scenario.
threshold	A numeric, for high FWER above this threshold we impose a penalty, default: 0.1.
penalty	A numeric, the scaling factor for FWER penalty, default: 1.
report_details	A logical, if TRUE, the function returns the output of the implicit call to baskwrap::get_details() as attr(, "details").
reduce_calculations	A logical, only takes effect for the "exact" backend. If TRUE, the function will only execute the get_details() function for p1 if the FWER for p2 turned out to be low enough. This may speed up function execution. Default is TRUE for the "exact" backend and FALSE otherwise.

Details

The utility function u_ewp is defined as defined as

$$u_{\text{ewp}}(x, \mathbf{p_1}, \mathbf{p_2}) = \text{ewp}(x, \mathbf{p_1}),$$

if the FWER fulfills $\text{fwer}(x, \mathbf{p_2}) < \eta_1$, and

$$u_{\text{ewp}}(x, \mathbf{p_1}, \mathbf{p_2}) = -\xi_1 \cdot \text{fwer}(x, \mathbf{p_2}),$$

if $\text{fwer}(x, \mathbf{p_2}) \geq \eta_1$. The parameter η_1 is called the threshold, the parameter ξ_1 is called the penalty.

The utility function u_ecd is defined analogously with the expected number of correct decisions (ECD) instead of the experiment-wise power. The use of ECD together with FWER constraints in the context of basket trials stems from Broglio et al. (2020).

Value

A numeric, the parameter combination's utility.

References

Broglio KR, Zhang F, Yu B, et al. A Comparison of Different Approaches to Bayesian Hierarchical Models in a Basket Trial to Evaluate the Benefits of Increasing Complexity. Statistics in Biopharmaceutical Research. 2022;14(3):324-333. doi:10.1080/19466315.2021.2008484

Examples

```
# Calculating the EWP utility using basksim as a backend
design <- baskwrap::setup_fujikawa_x(k = 3, shape1 = 1, shape2 = 1, p0 = 0.2)
u_ewp(design,
      x = list(lambda = 0.99, epsilon = 2, tau = 0.5),
      detail_params = list(p1 = c(0.5, 0.2, 0.2),
                           n = 20,
                           iter = 100,
                           logbase = exp(1)),
      penalty = 1, threshold = 0.1)
# Calculating the ECD utility using baskexact as a backend
design_x <- baskwrap::setup_fujikawa_x(k = 3, shape1 = 1, shape2 = 1,
                                       p0 = 0.2, backend = "exact")
u_ecd(design_x,
      x = list(lambda = 0.99, epsilon = 2, tau = 0.5),
      detail_params = list(p1 = c(0.5, 0.2, 0.2),
                           n = 20,
                           weight_fun = baskwrap::weights_jsd,
                           logbase = exp(1)),
      penalty = 1, threshold = 0.1)
```

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