Package 'PowerUpR'

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Type Package

Title R version of PowerUp!

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Description Tools to calculate statistical power, minimum detectable effect size,
and constrained optimal sample allocation for main and moderator effects
in various randomized controlled trials (individual- or cluster-level randomization, and single- or multi-site),
and for main effects in various regression discontinuity designs (individual- or cluster-level discontinuity, and single- or multi-site)
with continuous outcomes.

URL https://github.com/metinbulus/PowerUpR

BugReports https://github.com/metinbulus/PowerUpR/issues

Depends nloptr(>= 1.0.4)

Suggests knitr, rmarkdown

VignetteBuilder knitr

License GPL (>= 3)

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R topics documented:

`PowerUpR-package` *PowerUpR: R version of* PowerUp!

Description

PowerUp! series consists of three excel-based applications that allows researchers to conduct statistical power analysis for main effects (download link: *PowerUp!*), moderator effects (download link: *PowerUp!-Moderator*) and mediator effects (download link: *PowerUp!-Mediator*) for various multilevel randomized experiments and quasi-experiments. For more information please refer to `http://www.causalevaluation.org/`.

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`compare.cosa` *Compares COSA Solutions from Different Optimizers*

Description

`compare.cosa` compares COSA solutions from different optimizers for an object returned from one of the `cosa` functions.

Usage

```
compare.cosa(x)
```

Arguments

`x`	an object returned from one of the `cosa` functions.

Details

`compare.cosa` compares COSA solutions from different optimizers for an object returned from one of the `cosa` functions by passing parameters through `cosa` function.

Examples

```
## Not run:

    # object returned from cosa function
    design1 <- cosa.bira2r1(cn=1, cJ=10, cost=560,
                            constrain="cost", rho2=.20, omega2=.50)
    # compare COSA solution from different optimizers
    compare.cosa(design1)


## End(Not run)
```

`cosa.bcra3f2` *COSA Solver for Main Effect in Three-Level Fixed Effects Blocked Cluster Random Assignment Designs, Treatment at Level-2*

Description

`cosa.bcra3f2` finds constrained optimal sample allocation (COSA) solutions for main effect in designs with three-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (fixed blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bcra3f2(cn=0, cJ=0, cK=0, cost=NULL,
             n=NULL, J=NULL, K=NULL, P=NULL,
             nJK0=c(10,10,10), P0=.50,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
             rho2,
             g2=0,  R12=0, R22=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`P`	average proportion of level-2 units randomly assigned to treatment within level-3 units.
`nJK0`	vector with a length of three to specifiy starting values for level-1, level-2, and level-3 sample sizes.
`P0`	starting value for average proportion of level-2 units randomly assigned to treatment within level-3 units.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_slsqp"`, `"auglag_lbfgs"`, `"auglag_mma"` or `"auglag_cobyla"`.

gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bcra3f2, power.bcra3f2

Examples

```
## Not run:

     cosa.bcra3f2(cn=1, cJ=10, cK=100, cost=5600,
                  constrain="cost",
                  rho2=.10)


## End(Not run)
```

---

cosa.bcra3r2 *COSA Solver for Main Effect in Three-Level Random Effects Blocked Cluster Random Assignment Designs, Treatment at Level-2*

Description

cosa.bcra3r2 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with three-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (random blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bcra3r2(cn=0, cJ=0, cK=0, cost=NULL,
             n=NULL, J=NULL, K=NULL, P=NULL,
             nJK0=c(10,10,10), P0=.50,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
             rho2, rho3, omega3,
             g3=0, R12=0, R22=0, RT32=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cK	marginal cost per level-3 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
P	average proportion of level-2 units randomly assigned to treatment within level-3 units.
nJK0	vector with a length of three to specifiy starting values for level-1, level-2, and level-3 sample sizes.
P0	starting value for average proportion of level-2 units randomly assigned to treatment within level-3 units.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bcra3r2, power.bcra3r2

Examples

```
## Not run:

    cosa.bcra3r2(cn=1, cJ=10, cK=100, cost=5600,
                 constrain="cost",
                 rho3=.13, rho2=.10, omega3=.40)


## End(Not run)
```

---

cosa.bcra4f3 *COSA Solver for Main Effect in Four-Level Fixed Effects Blocked Cluster Random Assignment Designs, Treatment at Level-3*

Description

cosa.bcra4f3 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with four-levels where level-3 units are randomly assigned to treatment and control groups within level-4 units (fixed blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs (equal or unequal) per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bcra4f3(cn=0, cJ=0, cK=0, cL=0, cost=NULL,
             n=NULL, J=NULL, K=NULL, L=NULL, P=NULL,
             nJKL0=c(10,10,10,10), P0=.50,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
             rho3, rho2,
             g3=0, R32=0, R22=0, R12=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cK	marginal cost per level-3 unit.
cL	marginal cost per level-4 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
P	average proportion of level-3 units randomly assigned to treatment within level-4 units.
nJKL0	vector with a length of four to specifiy starting values for level-1, level-2, level-3, and level-4 sample sizes.
P0	starting value for average proportion of level-3 units randomly assigned to treatment within level-4 units.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bcra4f3, power.bcra4f3

Examples

```
## Not run:

    cosa.bcra4f3(cn=1, cJ=10, cK=100, cL=1000, cost=75600,
                 constrain="cost",
                 rho3=.15, rho2=.20)


## End(Not run)
```

---

cosa.bcra4r2 *COSA Solver for Main Effect in Four-Level Random Effects Block Random Assignment Designs, Treatment at Level-2*

Description

cosa.bcra4r2 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with four-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (random blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bcra4r2(cn=0, cJ=0, cK=0, cL=0, cost=NULL,
             n=NULL, J=NULL, K=NULL, L=NULL, P=NULL,
             nJKL0=c(10,10,10,10), P0=.50,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             constrain="power", optimizer="auglag_slsqp",
             gm=2, ncase=10,
             rho4, rho3, rho2, omega4, omega3,
             g4=0, RT42=0, RT32=0, R22=0, R12=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cK	marginal cost per level-3 unit.
cL	marginal cost per level-4 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.

P	average proportion of level-2 units randomly assigned to treatment within level-3 units.
nJKL0	vector with a length of four to specifiy starting values for level-1, level-2, level-3, and level-4 sample sizes.
P0	starting value for average proportion of level-2 units randomly assigned to treatment within level-3 units.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
omega4	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
RT42	proportion of treatment effect variance among level-4 units explained by level-4 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bcra4r2, power.bcra4r2

Examples

```
## Not run:

    cosa.bcra4r2(cn=1, cJ=10, cK=100, cL=1000, cost=75600,
                 constrain="cost",
                 rho4=.10, rho3=.15, rho2=.20,
                 omega4=.50, omega3=.50)


## End(Not run)
```

---

cosa.bcra4r3 *COSA Solver for Main Effect in Four-Level Random Effects Blocked Cluster Random Assignment Designs, Treatment at Level-3*

Description

cosa.bcra4r3 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with four-levels where level-3 units are randomly assigned to treatment and control groups within level-4 units (random blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bcra4r3(cn=0, cJ=0, cK=0, cL=0, cost=NULL,
             n=NULL, J=NULL, K=NULL, L=NULL, P=NULL,
             nJKL0=c(10,10,10,10), P0=.50,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
             rho4, rho3, rho2, omega4,
             g4=0, RT42=0, R32=0, R22=0, R12=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cK	marginal cost per level-3 unit.
cL	marginal cost per level-4 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.

P	average proportion of level-3 units randomly assigned to treatment within level-4 units.
nJKL0	vector with a length of four to specifiy starting values for level-1, level-2, level-3, and level-4 sample sizes.
P0	starting value for average proportion of level-3 units randomly assigned to treatment within level-4 units.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
omega4	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
RT42	proportion of treatment effect variance among level-4 units explained by level-4 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bcra4r3, power.bcra4r3

Examples

```
## Not run:

    cosa.bcra4r3(cn=1, cJ=10, cK=100, cL=1000, cost=75600,
                 constrain="cost",
                 rho4=.10, rho3=.15, rho2=.20,
                 omega4=.50)


## End(Not run)
```

`cosa.bcrd3f2` *COSA Solver for Three-Level Blocked Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2 (Fixed Treatment Effect)*

Description

COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit while minimizing sampling variance fo the treatment effect, (ii) under power constraints given marginal costs per unit while minimizing the total cost, (ii) under MDES constraints given marginal costs per unit while minimizing the total cost, and (iv) under sample size constraints for one or more levels along with any of the i ii, or iii options.

Usage

```
cosa.bcrd3f2(cn, cJ, cK, cost=NULL,
             n=NULL, J=NULL, K=NULL, nJK0=c(10,10,10),
             constrain="power", optimizer="auglag_slsqp",
             gm=2, ncase=10,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             rho2,
             P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
             g2=0, R12=0, R22=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`nJK0`	vector with a length of three to specifiy starting values for level-1, level-2, and level-3 sample sizes.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.

alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation untis from full normal distribution mean).
k2	right truncation point (in standard deviation untis from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bcrd3f2, power.bcrd3f2

Examples

```
## Not run:

      cosa.bcrd3f2(cn=1, cJ=10, cK=100, cost=5600, constrain="cost",
mdes=0.24, rho2=.20)


## End(Not run)
```

`cosa.bcrd3r2` *COSA Solver for Three-Level Blocked Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2 (Random Treatment Effect)*

Description

COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit while minimizing sampling variance fo the treatment effect, (ii) under power constraints given marginal costs per unit while minimizing the total cost, (ii) under MDES constraints given marginal costs per unit while minimizing the total cost, and (iv) under sample size constraints for one or more levels along with any of the i ii, or iii options.

Usage

```
cosa.bcrd3r2(cn=0, cJ=0, cK=0, cost=0,
             n=NULL, J=NULL, K=NULL, nJK0=c(10,10,10),
             constrain="power", optimizer="auglag_slsqp",
             gm=2, ncase=10,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             rho2, rho3, omega3,
             P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
             g3=0, R12=0, R22=0, RT32=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`nJK0`	vector with a length of three to specifiy starting values for level-1, level-2, and level-3 sample sizes.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_slsqp"`, `"auglag_lbfgs"`, `"auglag_mma"` or `"auglag_cobyla"`.
`gm`	grid multiplier to increase the range of sample sizes for approximate integer solutions.

ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation untis from full normal distribution mean).
k2	right truncation point (in standard deviation untis from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bcrd3r2, power.bcrd3r2

Examples

```
## Not run:

        cosa.bcrd3r2(cn=1, cJ=10, cK=100, cost=5600, constrain="power",
mdes=0.367, rho3=.15, rho2=.20, omega3=.50)


## End(Not run)
```

`cosa.bira2c1` *COSA Solver for Main Effect in Two-Level Constant Effects Blocked Individual Random Assignment Designs, Treatment at Level-2*

Description

`cosa.bira2c1` finds constrained optimal sample allocation (COSA) solutions for main effct in designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (school intercepts only). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bira2c1(cn=0, cJ=0, cost=NULL,
             n=NULL, J=NULL, P=NULL,
             nJ0=c(10,10), P0=.50,
             constrain="power", optimizer="auglag_slsqp",
             gm=2, ncase=10,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             g1=0, R12=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	level-2 sample size.
`P`	average proportion of level-1 units randomly assigned to treatment within level-2 units.
`nJ0`	vector with a length of two to specifiy starting values for level-1 and level-2 sample sizes.
`P0`	starting value for average proportion of level-1 units randomly assigned to treatment within level-2 units.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_slsqp"`, `"auglag_lbfgs"`, `"auglag_mma"` or `"auglag_cobyla"`.
`gm`	grid multiplier to increase the range of sample sizes for approximate integer solutions.
`ncase`	number of approximate integer solutions to be exported.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.

two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bira2c1, power.bira2c1

Examples

```
## Not run:

     cosa.bira2c1(cn=1, cJ=10, cost=560,
                   constrain="cost")


## End(Not run)
```

---

cosa.bira2f1 *COSA Solver for Main Effect in Two-Level Fixed Effects Blocked Individual Random Assignment Designs, Treatment at Level-1*

Description

cosa.bira2f1 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (fixed blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bira2f1(cn=0, cJ=0, cost=NULL,
             n=NULL, J=NULL, P=NULL,
             nJ0=c(10,10), P0=.50,
             constrain="power", optimizer="auglag_slsqp",
             gm=2, ncase=10,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             g1=0, R12=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
nJ0	vector with a length of two to specifiy starting values for level-1 and level-2 sample sizes.
P0	starting value for average proportion of level-1 units randomly assigned to treatment within level-2 units.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bira2f1, power.bira2f1

Examples

```
## Not run:

     cosa.bira2f1(cn=1, cJ=10, cost=560,
                   constrain="cost")


## End(Not run)
```

---

cosa.bira2r1 *COSA Solver for Main Effect in Two-Level Random Effects Blocked Individual Random Assignment Designs, Individuals Randomized within Blocks*

Description

cosa.bira2r1 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bira2r1(cn=0, cJ=0, cost=NULL,
              n=NULL, J=NULL, P=NULL,
              nJ0=c(10,10), P0=.50,
              power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
              constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
              rho2, omega2,
              g2=0, R12=0, RT22=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
nJ0	vector with a length of two to specifiy starting values for level-1 and level-2 sample sizes.
P0	starting value for average proportion of level-1 units randomly assigned to treatment within level-2 units.

power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bira2r1, power.bira2r1

Examples

```
## Not run:

    cosa.bira2r1(cn=1, cJ=10, cost=560,
                 constrain="cost", rho2=.20, omega2=.50)


## End(Not run)
```

`cosa.bira3r1` *COSA Solver for Main Effect in Three-Level Random Effects Blocked Individual Random Assignment Design, Individuals Randomized within Blocks*

Description

`cosa.bira3r1` finds constrained optimal sample allocation (COSA) solutions for main effect in designs with three-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bira3r1(cn=0, cJ=0, cK=0, cost=NULL,
             n=NULL, J=NULL, K=NULL, P=NULL,
             nJK0=c(10,10,10), P0=.50,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
             rho2, rho3, omega2, omega3,
             g3=0, R12=0, RT22=0, RT32=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`P`	average proportion of level-1 units randomly assigned to treatment within level-2 units.
`nJK0`	vector with a length of three to specifiy starting values for level-1, level-2, and level-3 sample sizes.
`P0`	starting value for average proportion of level-1 units randomly assigned to treatment within level-2 units.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.

optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bira3r1, power.bira3r1

Examples

```
## Not run:

     cosa.bira3r1(cn=1, cJ=10, cK=100, cost=5600,
                  constrain="cost",
                  rho3=.20, rho2=.15, omega3=.10, omega2=.10)


## End(Not run)
```

cosa.bira4r1 *COSA Solver for Main Effect in Four-Level Random Effects Blocked Individual Random Assignment Design, Individuals Randomized within Blocks*

Description

cosa.bira4r1 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with four-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks). COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.bira4r1(cn=0, cJ=0, cK=0, cL=0, cost=NULL,
             n=NULL, J=NULL, K=NULL, L=NULL, P=NULL,
             nJKL0=c(10,10,10,10), P0=.50,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
             rho4, rho3, rho2, omega4, omega3, omega2,
             g4=0, RT42=0, RT32=0, RT22=0, R12=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cK	marginal cost per level-3 unit.
cL	marginal cost per level-4 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
nJKL0	vector with a length of four to specifiy starting values for level-1, level-2, level-3, and level-4 sample sizes.
P0	starting value for average proportion of level-1 units randomly assigned to treatment within level-2 units.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.

constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
omega4	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
RT42	proportion of treatment effect variance among level-4 units explained by level-4 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bira4r1, power.bira4r1

Examples

```
## Not run:

    cosa.bira4r1(cn=1, cJ=10, cK=100, cL=1000, cost=75600,
                 constrain="cost",
                 rho4=.10, rho3=.15, rho2=.20,
```

```
                    omega4=.50, omega3=.50, omega2=.50)

## End(Not run)
```

`cosa.bird2f1` *COSA Solver for Two-Level Blocked Individual Regression Discontinuity Design, Treatment Based on Discontinuity at Level-1 (Fixed Treatment Effect)*

Description

COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit while minimizing sampling variance fo the treatment effect, (ii) under power constraints given marginal costs per unit while minimizing the total cost, (ii) under MDES constraints given marginal costs per unit while minimizing the total cost, and (iv) under sample size constraints for one or more levels along with any of the i ii, or iii options.

Usage

```
cosa.bird2f1(cn=0, cJ=0, cost=NULL,
             n=NULL, J=NULL, nJ0=c(10,10),
             constrain="power", optimizer="auglag_slsqp",
             gm=2, ncase=10,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
             g1=0, R12=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	number of level-2 units.
`nJ0`	vector with a length of two to specifiy starting values for level-1, and level-2 sample sizes.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_slsqp"`, `"auglag_lbfgs"`, `"auglag_mma"` or `"auglag_cobyla"`.
`gm`	grid multiplier to increase the range of sample sizes for approximate integer solutions.

ncase	number of approximate integer solutions to be exported.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation untis from full normal distribution mean).
k2	right truncation point (in standard deviation untis from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bird2f1, power.bird2f1

Examples

```
## Not run:

     cosa.bird2f1(mdes=0.728, cn=1, cJ=10, cost=560, constrain="cost")


## End(Not run)
```

---

cosa.bird2r1 *COSA Solver for Two-Level Blocked Individual Regression Discontinuity Design, Treatment Based on Discontinuity at Level-1 (Random Treatment Effect)*

Description

COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit while minimizing sampling variance fo the treatment effect, (ii) under power constraints given marginal costs per unit while minimizing the total cost, (ii) under MDES constraints given marginal costs per unit while minimizing the total cost, and (iv) under sample size constraints for one or more levels along with any of the i ii, or iii options.

Usage

```
cosa.bird2r1(cn=0, cJ=0, cost=NULL,
             n=NULL, J=NULL, nJ0=c(10,10),
             constrain="power", optimizer="auglag_slsqp",
             gm=2, ncase=10,
             power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
             rho2, omega2,
             P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
             g2=0, R12=0, RT22=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	number of level-2 units.
nJ0	vector with a length of two to specifiy starting values for level-1, and level-2 sample sizes.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation untis from full normal distribution mean).
k2	right truncation point (in standard deviation untis from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.bird2r1, power.bird2r1

Examples

```
## Not run:

    cosa.bird2r1(mdes=0.0446, cn=1, cJ=10, cost=560,
                  constrain="cost", rho2=.20, omega2=.50)


## End(Not run)
```

---

cosa.cra2r2 *COSA Solver for Main Effect in Two-Level Cluster Random Assignment Design, Treatment at Level-2*

Description

cosa.cra2r2 finds constrained optimal sample allocation (COSA) solutions for main effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.cra2r2(cn=0, cJ=0, cost=NULL,
              n=NULL, J=NULL, P=NULL,
            nJ0=c(10,10), P0=.50,
            constrain="power", optimizer="auglag_slsqp",
            gm=2, ncase=10,
              power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
              rho2, g2=0, R12=0, R22=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
P	proportion of level-2 units randomly assigned to treatment.
nJ0	vector with a length of two to specifiy starting values for level-1 and level-2 sample sizes.
P0	starting value for proportion of level-2 units randomly assigned to treatment.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.cra2r2, power.cra2r2

Examples

```
## Not run:

    cosa.cra2r2(cn=1, cJ=10, cost=560,
                  constrain="cost", rho2=.20)


## End(Not run)
```

`cosa.cra3r3` *COSA Solver for Main Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3*

Description

`cosa.cra3r3` finds constrained optimal sample allocation (COSA) solutions for main effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.cra3r3(cn=0, cJ=0, cK=0, cost=NULL,
              n=NULL, J=NULL, K=NULL, P=NULL,
            nJK0=c(10,10,10), P0=.50,
              power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
              constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
              rho2, rho3,
              g3=0, R12=0, R22=0, R32=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`P`	proportion of level-3 units randomly assigned to treatment.
`nJK0`	vector with a length of three to specifiy starting values for level-1, level-2, and level-3 sample sizes.
`P0`	starting value for proportion of level-3 units randomly assigned to treatment.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.

alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.cra3r3, power.cra3r3

Examples

```
## Not run:

     cosa.cra3r3(cn=1, cJ=10, cK=100, cost=5600,
                   constrain="cost",
                   rho3=.06, rho2=.17)


## End(Not run)
```

`cosa.cra4r4` *COSA Solver for Main Effect in Four-Level Cluster Random Assignment Designs, Treatment at Level-4*

Description

`cosa.cra4r4` finds constrained optimal sample allocation (COSA) solutions for main effect in designs with four-levels where level-4 units are randomly assigned to treatment and control groups. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.cra4r4(cn=0, cJ=0, cK=0, cL=0, cost=NULL,
              n=NULL, J=NULL, K=NULL, L=NULL, P=NULL,
            nJKL0=c(10,10,10,10), P0=.50,
              power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
              constrain="power", optimizer="auglag_slsqp", gm=2, ncase=10,
              rho4, rho3, rho2,
              g4=0, R42=0, R32=0, R22=0, R12=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cL`	marginal cost per level-4 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	harmonic mean of level-3 units across level-4 units (or simple average).
`L`	number of level-4 units.
`P`	proportion of level-4 units randomly assigned to treatment.
`nJKL0`	vector with a length of four to specifiy starting values for level-1, level-2, level-3, and level-4 sample sizes.
`P0`	starting value for proportion of level-4 units randomly assigned to treatment.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.

optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
R42	proportion of level-4 variance in the outcome explained by level-4 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.cra4r4, power.cra4r4

Examples

```
## Not run:

     cosa.cra4r4(cn=1, cJ=10, cK=100, cL=1000, cost=75600,
                 constrain="cost",
                 rho4=.05, rho3=.05, rho2=.10)


## End(Not run)
```

`cosa.crd2r2` *COSA Solver for Two-Level Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2*

Description

COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit while minimizing sampling variance fo the treatment effect, (ii) under power constraints given marginal costs per unit while minimizing the total cost, (ii) under MDES constraints given marginal costs per unit while minimizing the total cost, and (iv) under sample size constraints for one or more levels along with any of the i ii, or iii options.

Usage

```
cosa.crd2r2(cn=0, cJ=0, cost=NULL,
            n=NULL, J=NULL, nJ0=c(10,10),
            constrain="power", optimizer="auglag_slsqp",
            gm=2, ncase=10,
              power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
              rho2,
              P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
              g2=0, R12=0, R22=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`nJ0`	vector with a length of two to specifiy starting values for level-1, and level-2 sample sizes.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_slsqp"`, `"auglag_lbfgs"`, `"auglag_mma"` or `"auglag_cobyla"`.
`gm`	grid multiplier to increase the range of sample sizes for approximate integer solutions.
`ncase`	number of approximate integer solutions to be exported.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`P`	average proportion of level-1 units randomly assigned to treatment within level-2 units.

RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation untis from full normal distribution mean).
k2	right truncation point (in standard deviation untis from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.crd2r2, power.crd2r2

Examples

```
## Not run:

     cosa.crd2r2(constrain="cost", cost=560, cn=1, cJ=10,
rho2=.20)


## End(Not run)
```

---

cosa.crd3r3 *COSA Solver for Three-Level Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-3*

Description

COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit while minimizing sampling variance fo the treatment effect, (ii) under power constraints given marginal costs per unit while minimizing the total cost, (ii) under MDES constraints given marginal costs per unit while minimizing the total cost, and (iv) under sample size constraints for one or more levels along with any of the i ii, or iii options.

Usage

```
cosa.crd3r3(cn=0, cJ=0, cK=0, cost=NULL,
              n=NULL, J=NULL, K=NULL, nJK0=c(10,10,10),
            constrain="power", optimizer="auglag_slsqp",
            gm=2, ncase=10,
              power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
              rho2, rho3,
              P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
              g3=0, R12=0, R22=0, R32=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cK	marginal cost per level-3 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
nJK0	vector with a length of three to specifiy starting values for level-1, level-2, and level-3 sample sizes.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_slsqp", "auglag_lbfgs", "auglag_mma" or "auglag_cobyla".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation untis from full normal distribution mean).
k2	right truncation point (in standard deviation untis from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.crd3r3, power.crd3r3

Examples

```
## Not run:

     cosa.crd3r3(constrain="cost", cost=5600, cn=1, cJ=10, cK=100,
mdes=0.447, rho2=.20, rho3=.10)


## End(Not run)
```

---

cosa.ira1r1 *Sample Size Calculator for Main Effect in Individual Random Assignment Designs, Completely Randomized Controlled Trials*

Description

cosa.ira1r1 calculates minimum required sample size for main effect in completely randomized controlled trials where individuals are randomly assigned to treatment or control groups.

Usage

```
cosa.ira1r1(mdes=.25, power=.80, alpha=.05, two.tail=TRUE,
                      n0=10, tol=.10,
                      P=.50, g1=0, R12=0)
```

Arguments

power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
n0	starting value for sample size.
tol	tolerance.

P	average proportion of units randomly assigned to treatment.
g1	number of covariates.
R12	proportion of variance in the outcome explained by covariates.

Value

fun	function name.
parms	list of parameters used in the function.
n	sample size.

See Also

mdes.ira1r1, power.ira1r1

Examples

```
## Not run:

    cosa.ira1r1(R12=.50)


## End(Not run)
```

---

cosa.ird1r1 *COSA for Main Effect in Individual Regression Discontinuity Design*

Description

cosa.ird1r1 calculates constrained optimal sample for main effect in individual regression discontinuity design.

Usage

```
cosa.ird1r1(mdes=.25, power=.80, alpha=.05, two.tail=TRUE,
                    n0=10, tol=.10,
 P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                    g1=0, R12=0)
```

Arguments

power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
n0	starting value for sample size.
tol	tolerance.
P	average proportion of units randomly assigned to treatment.
RTZ	correlation between treatment status and assignment variable.

k1	left truncation point (in standard deviation untis from full normal distribution mean).
k2	right truncation point (in standard deviation untis from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g1	number of covariates.
R12	proportion of variance in the outcome explained by covariates.

Value

fun	function name.
parms	list of parameters used in the function.
n	sample size.

See Also

mdes.ird1r1, power.ird1r1

Examples

```
## Not run:

     cosa.ird1r1(mdes=.466)


## End(Not run)
```

---

cosa.mod1n.cra2r2 *COSA Solver for Non-randomly Varying Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment at level-2 and Moderator at Level-1*

Description

cosa.mod1n.cra2r2 finds constrained optimal sample allocation (COSA) solutions for non-randomly varying moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-1. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
  cosa.mod1n.cra2r2(cn=0, cJ=0, cost=NULL,
n=NULL, J=NULL, P=NULL, nJ0=c(10,10), P0=.50,
constrain="power", optimizer="auglag_slsqp",
gm=2, ncase=10,
                    power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                    rho2, Q=NULL, g1=0, R12=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
P	proportion of level-2 units randomly assigned to treatment.
nJ0	vector with a length of two to specifiy starting values for level-1 and level-2 sample sizes.
P0	starting value for proportion of level-2 units randomly assigned to treatment.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_cobyla", "auglag_lbfgs", "auglag_mma", or "auglag_slsqp".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod1n.cra2r2, power.mod1n.cra2r2

Examples

```
## Not run:

     cosa.mod1n.cra2r2(cn=1, cJ=10, cost=560,
                         constrain="cost", rho2=.20)


## End(Not run)
```

`cosa.mod1n.cra3r3` *COSA Solver for Non-randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3 and Moderator at Level-1*

Description

`cosa.mod1n.cra3r3` finds constrained optimal sample allocation (COSA) solutions for non-randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-1. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
  cosa.mod1n.cra3r3(cn=0, cJ=0, cK=0, cost=NULL,
                 n=NULL, J=NULL, K=NULL, P=NULL, nJK0=c(10,10,10), P0=.50,
 constrain="power", optimizer="auglag_slsqp",
 gm=2, ncase=10,
                 power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                 rho2, rho3, Q=NULL, g1=0, R12=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`P`	proportion of level-3 units randomly assigned to treatment.
`nJK0`	vector with a length of two to specifiy starting values for level-1, level-2 and level-3 sample sizes.
`P0`	starting value for proportion of level-3 units randomly assigned to treatment.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.

optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_cobyla", "auglag_lbfgs", "auglag_mma", or "auglag_slsqp".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod1n.cra3r3, power.mod1n.cra3r3

Examples

```
## Not run:

    cosa.mod1n.cra3r3(cn=1, cJ=10, cK=100, n=10, constrain="mdes",
                      rho2=.20, rho3=.10)


## End(Not run)
```

`cosa.mod1r.cra2r2` *COSA Solver for Randomly Varying Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment at level-2 and Moderator at Level-1*

Description

`cosa.mod1r.cra2r2` finds constrained optimal sample allocation (COSA) solutions for randomly varying moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-1. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.mod1r.cra2r2(cn=0, cJ=0, cost=NULL,
n=NULL, J=NULL, P=NULL, nJ0=c(10,10), P0=.50,
constrain="power", optimizer="auglag_slsqp",
gm=2, ncase=10,
                power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                rho2, omega2, Q=NULL, g1=0, R12=0, RT22=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	level-2 sample size.
`P`	proportion of level-2 units randomly assigned to treatment.
`nJ0`	vector with a length of two to specifiy starting values for level-1 and level-2 sample sizes.
`P0`	starting value for proportion of level-2 units randomly assigned to treatment.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_slsqp"`, `"auglag_lbfgs"`, `"auglag_mma"`, or `"auglag_slsqp"`.
`gm`	grid multiplier to increase the range of sample sizes for approximate integer solutions.
`ncase`	number of approximate integer solutions to be exported.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.

rho2	proportion of variance in the outcome explained by level-2 units.
omega2	moderator effect heterogeneity (unconditional) across level-2 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of level-2 variance in the moderator effect explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod1r.cra2r2, power.mod1r.cra2r2

Examples

```
## Not run:

     cosa.mod1r.cra2r2(cn=1, cJ=10, cost=560,
                         constrain="cost", rho2=.20, omega=.20)


## End(Not run)
```

---

cosa.mod1r.cra3r3 *COSA Solver for Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3 and Moderator at Level-1*

Description

cosa.mod1r.cra3r3 finds constrained optimal sample allocation (COSA) solutions for randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-1. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
 cosa.mod1r.cra3r3(cn=0, cJ=0, cK=0, cost=NULL,
                n=NULL, J=NULL, K=NULL, P=NULL, nJK0=c(10,10,10), P0=.50,
constrain="power", optimizer="auglag_slsqp",
gm=2, ncase=10,
                power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                rho2, rho3, omega2, omega3, Q=NULL,
                g1=0, R12=0, RT22=0, RT32=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cK	marginal cost per level-3 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
P	proportion of level-3 units randomly assigned to treatment.
nJK0	vector with a length of two to specifiy starting values for level-1, level-2 and level-3 sample sizes.
P0	starting value for proportion of level-3 units randomly assigned to treatment.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_cobyla", "auglag_lbfgs", "auglag_mma", or "auglag_slsqp".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega2	moderator effect heterogeneity (unconditional) across level-2 units.
omega3	moderator effect heterogeneity (unconditional) across level-3 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of level-2 variance in the moderator effect explained by level-2 covariates.
RT32	proportion of level-3 variance in the moderator effect explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod1r.cra3r3, power.mod1r.cra3r3

Examples

```
## Not run:

      cosa.mod1r.cra3r3(cn=1, cJ=10, cK=100, n=10, constrain="mdes",
                            rho2=.20, rho3=.10, omega2=.10, omega3=.10)


## End(Not run)
```

---

cosa.mod2.cra2r2 *COSA Solver for Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment and Moderator at Level-2*

Description

cosa.mod2.cra2r2 finds constrained optimal sample allocation (COSA) solutions for moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-2. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
cosa.mod2.cra2r2(cn=0, cJ=0, cost=NULL,
n=NULL, J=NULL, P=NULL, nJ0=c(10,10), P0=.50,
constrain="power", optimizer="auglag_slsqp",
gm=2, ncase=10,
                power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                rho2, Q=NULL, g2=0, R12=0, R22=0)
```

Arguments

cn	marginal cost per level-1 unit.
cJ	marginal cost per level-2 unit.
cost	total cost or budget.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
P	proportion of level-2 units randomly assigned to treatment.
nJ0	vector with a length of two to specifiy starting values for level-1 and level-2 sample sizes.
P0	starting value for proportion of level-2 units randomly assigned to treatment.
constrain	one of the followings can be constrained at a specified cost or value: "cost", "power", or "mdes".
optimizer	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: "auglag_cobyla", "auglag_lbfgs", "auglag_mma", or "auglag_slsqp".
gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g2	number of covariates at level-2 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod2.cra2r2, power.mod2.cra2r2

Examples

```
## Not run:

     cosa.mod2.cra2r2(cn=1, cJ=10, cost=560,
                          constrain="cost", rho2=.20)

## End(Not run)
```

`cosa.mod2n.cra3r3` *COSA Solver for Non-Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3 and Moderator at Level-2*

Description

`cosa.mod2n.cra3r3` finds constrained optimal sample allocation (COSA) solutions for non-randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-2. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
  cosa.mod2n.cra3r3(cn=0, cJ=0, cK=0, cost=NULL,
                 n=NULL, J=NULL, K=NULL, P=NULL, nJK0=c(10,10,10), P0=.50,
constrain="power", optimizer="auglag_slsqp",
gm=2, ncase=10,
                 power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                 rho2, rho3, Q=NULL, g2=0, R12=0, R22=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`P`	proportion of level-3 units randomly assigned to treatment.
`nJK0`	vector with a length of two to specifiy starting values for level-1, level-2 and level-3 sample sizes.
`P0`	starting value for proportion of level-3 units randomly assigned to treatment.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_cobyla"`, `"auglag_lbfgs"`, `"auglag_mma"`, or `"auglag_slsqp"`.

gm	grid multiplier to increase the range of sample sizes for approximate integer solutions.
ncase	number of approximate integer solutions to be exported.
power	statistical power (1 - type II error).
mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g2	number of covariates at level-2 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod2n.cra3r3, power.mod2n.cra3r3

Examples

```
## Not run:

      cosa.mod2n.cra3r3(cn=1, cJ=10, cK=100, n=10, constrain="mdes",
                        rho2=.20, rho3=.10)


## End(Not run)
```

`cosa.mod2r.cra3r3` *COSA Solver for Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3 and Moderator at Level-2*

Description

`cosa.mod2r.cra3r3` finds constrained optimal sample allocation (COSA) solutions for randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-2. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
 cosa.mod2r.cra3r3(cn=0, cJ=0, cK=0, cost=NULL,
                n=NULL, J=NULL, K=NULL, P=NULL, nJK0=c(10,10,10), P0=.50,
constrain="power", optimizer="auglag_slsqp",
gm=2, ncase=10,
                power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                rho2, rho3, omega3, Q=NULL,
                g2=0, R12=0, R22=0, RT32=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`P`	proportion of level-3 units randomly assigned to treatment.
`nJK0`	vector with a length of two to specifiy starting values for level-1, level-2 and level-3 sample sizes.
`P0`	starting value for proportion of level-3 units randomly assigned to treatment.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_cobyla"`, `"auglag_lbfgs"`, `"auglag_mma"`, or `"auglag_slsqp"`.
`gm`	grid multiplier to increase the range of sample sizes for approximate integer solutions.
`ncase`	number of approximate integer solutions to be exported.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.

alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega3	moderator effect heterogeneity (unconditional) across level-3 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g2	number of covariates at level-2 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of level-3 variance in the moderator effect explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod2r.cra3r3, power.mod2r.cra3r3

Examples

```
## Not run:

      cosa.mod2r.cra3r3(cn=1, cJ=10, cK=100, n=10, constrain="mdes",
                            rho2=.20, rho3=.10, omega3=.10)


## End(Not run)
```

`cosa.mod3.cra3r3` *COSA Solver for Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment and Moderator at Level-3*

Description

`cosa.mod3.cra3r3` finds constrained optimal sample allocation (COSA) solutions for moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-3. COSA can be found in the following forms, (i) under budgetary constraints given marginal costs per unit, (ii) under power contraints given marginal costs per unit, (iii) under MDES contraints given marginal costs per unit, and (iv) under sample size contraints for one or more levels along with any of the i,ii, or iii options.

Usage

```
 cosa.mod3.cra3r3(cn=0, cJ=0, cK=0, cost=NULL,
                n=NULL, J=NULL, K=NULL, P=NULL, nJK0=c(10,10,10), P0=.50,
constrain="power", optimizer="auglag_slsqp",
gm=2, ncase=10,
                power=.80, mdes=.25, alpha=.05, two.tail=TRUE,
                rho2, rho3, Q=NULL,
                g3=0, R12=0, R22=0, R32=0)
```

Arguments

`cn`	marginal cost per level-1 unit.
`cJ`	marginal cost per level-2 unit.
`cK`	marginal cost per level-3 unit.
`cost`	total cost or budget.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`P`	proportion of level-3 units randomly assigned to treatment.
`nJK0`	vector with a length of two to specifiy starting values for level-1, level-2 and level-3 sample sizes.
`P0`	starting value for proportion of level-3 units randomly assigned to treatment.
`constrain`	one of the followings can be constrained at a specified cost or value: `"cost"`, `"power"`, or `"mdes"`.
`optimizer`	algorithm to find optimal sample sizes given total cost, power, or MDES. Available algorithms: `"auglag_cobyla"`, `"auglag_lbfgs"`, `"auglag_mma"`, or `"auglag_slsqp"`.
`gm`	grid multiplier to increase the range of sample sizes for approximate integer solutions.
`ncase`	number of approximate integer solutions to be exported.
`power`	statistical power (1 - type II error).
`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.

two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g3	number of covariates at level-3 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.

Value

fun	function name.
parms	list of parameters used in the function.
nloptr	list of nloptr log and output.
exact.optim	exact solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
round.optim	rounded solution. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).
integer.optim	approximate integer solutions. MDES is calculated at the specified power (default .80), and power is calculated at the specified MDES (default .25).

See Also

mdes.mod3.cra3r3, power.mod3.cra3r3

Examples

```
## Not run:

      cosa.mod3.cra3r3(cn=1, cJ=10, cK=100, n=10, constrain="mdes",
                       rho2=.20, rho3=.10)


## End(Not run)
```

---

cosa.to.mdes *COSA to MDES*

Description

cosa.to.mdes converts an object returned from cosa function into an object returned from mdes function.

Usage

```
cosa.to.mdes(x)
```

Arguments

x	an object returned from one of the cosa functions.

Details

cosa.to.mdes converts an object returned from cosa function into an object returned from mdes function by passing parameters through mdes function.

See Also

cosa.to.power

Examples

```
## Not run:

     # object returned from cosa function
     design1 <- cosa.bira2r1(cn=1, cJ=10, cost=560,
                             constrain="cost", rho2=.20, omega2=.50)
     # convert the object into an object returned from mdes function
     design2 <- cosa.to.mdes(design1)


## End(Not run)
```

---

cosa.to.power *COSA to Power*

Description

cosa.to.power converts an object returned from cosa function into an object returned from power function.

Usage

```
cosa.to.power(x)
```

Arguments

x	an object returned from one of the cosa functions.

Details

cosa.to.power converts an object returned from cosa function into an object returned from power function by passing parameters through power function.

See Also

cosa.to.mdes

Examples

```
## Not run:

     # object returned from cosa function
     design1 <- cosa.bira2r1(cn=1, cJ=10, cost=560,
                              constrain="cost", rho2=.20, omega2=.50)
     # convert the object into an object returned from power function
     design2 <- cosa.to.power(design1)


## End(Not run)
```

`mdes.bcra3f2` *MDES Calculator for Three-Level Fixed Effects Blocked Cluster Random Assignment Design, Treatment at Level-2*

Description

`mdes.bcra3f2` calculates minimum detectable effect size (MDES) for designs with three-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (fixed blocks).

Usage

```
mdes.bcra3f2(power=.80, alpha=.05, two.tail=TRUE,
             rho2, P=.50, g2=0, R12=0, R22=0,
             n, J, K, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`P`	average proportion of level-2 units randomly assigned to treatment within level-3 units.
`g2`	number of covariates at level-2.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bcra3f2, cosa.bcra3f2

Examples

```
## Not run:

 mdes.bcra3f2(rho2=.10, n=20, J=44, K=5)


## End(Not run)
```

---

mdes.bcra3r2 *MDES Calculator for Three-Level Random Effects Blocked Cluster Random Assignment Designs, Treatment at Level-2*

Description

mdes.bcra3r2 calculates minimum detectable effect size (MDES) for designs with three-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (random blocks).

Usage

```
mdes.bcra3r2(power=.80, alpha=.05, two.tail=TRUE,
             rho2, rho3, omega3,
             P=.50, g3=0, R12=0, R22=0, RT32=0,
             n, J, K, ...)
```

Arguments

power	statistical power $(1-\beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
P	average proportion of level-2 units randomly assigned to treatment within level-3 units.

g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bcra3r2, cosa.bcra3r2

Examples

```
## Not run:

 mdes.bcra3r2(rho3=.13, rho2=.10, omega3=.40,
              n=10, J=6, K=24)


## End(Not run)
```

---

mdes.bcra4f3 *MDES Calculator for Four-Level Fixed Effects Blocked Cluster Random Assignment Designs, Treatment at Level-3*

Description

mdes.bcra4f3 calculates minimum detectable effect size (MDES) for designs with four-levels where level-3 units are randomly assigned to treatment and control groups within level-4 units (fixed blocks).

Usage

```
mdes.bcra4f3(power=.80, alpha=.05, two.tail=TRUE,
     rho2, rho3,
     P=.50, R12=0, R22=0, R32=0, g3=0,
     n, J, K, L, ...)
```

Arguments

power	statistical power $(1 - \beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	average proportion of level-3 units randomly assigned to treatment within level-4 units.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bcra4f3, cosa.bcra4f3

Examples

```
## Not run:

  mdes.bcra4f3(rho3=.15, rho2=.15,
               n=10, J=4, K=4, L=15)

## End(Not run)
```

mdes.bcra4r2 *MDES Calculator for Four-Level Random Effects Block Random Assignment Designs, Treatment at Level-2*

Description

mdes.bcra4r2 calculates minimum detectable effect size (MDES) for designs with four-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (random blocks).

Usage

```
mdes.bcra4r2(power=.80, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4, omega3, omega4,
     P=.50, R12=0, R22=0, RT32=0, RT42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

power	statistical power $(1 - \beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
omega4	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
P	average proportion of level-2 units randomly assigned to treatment within level-3 units.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
RT42	proportion of treatment effect variance among level-4 units explained by level-4 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bcra4r2, cosa.bcra4r2

Examples

```
## Not run:

  mdes.bcra4r2(rho4=.05, rho3=.15, rho2=.15,
              omega4=.50, omega3=.50,
              n=10, J=4, L=27, K=4)

## End(Not run)
```

---

mdes.bcra4r3 *MDES Calculator for Four-Level Random Effects Blocked Cluster Random Assignment Designs, Treatment at Level-3*

Description

mdes.bcra4r3 calculates minimum detectable effect size (MDES) for designs with four-levels where level-3 units are randomly assigned to treatment and control groups within level-4 units (random blocks).

Usage

```
mdes.bcra4r3(power=.80, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4, omega4,
     P=.50, R12=0, R22=0, R32=0, RT42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

power	statistical power $(1-\beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
omega4	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.

P	average proportion of level-3 units randomly assigned to treatment within level-4 units.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
RT42	proportion of treatment effect variance among level-4 units explained by level-4 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and 95% lower and upper confidence limits.

See Also

power.bcra4r3, cosa.bcra4r3

Examples

```
## Not run:

  mdes.bcra4r3(rho4=.05, rho3=.15, rho2=.15,
               omega4=.50,
               n=10, J=4, L=27, K=4)

## End(Not run)
```

---

mdes.bcrd3f2 *MDES Calculator for Three-Level Blocked Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2 (Fixed Treatment Effect)*

Description

Minimum detectable effect size calculator for three-level blocked cluster regression discontinuity design where treatment assignment is based on discontinuity at level-2 (fixed treatment effect).

Usage

```
mdes.bcrd3f2(power=.80, alpha=.05, two.tail=TRUE,
                        rho2, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                        P=.50, g2=0, R12=0, R22=0,
 n, J, K, ...)
```

Arguments

power	statistical power (1 - type II error).
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

cosa.bcrd3f2, power.bcrd3f2

Examples

```
## Not run:

     mdes.bcrd3f2(rho2=.20, n=10, J=5, K=100)


## End(Not run)
```

`mdes.bcrd3r2` *MDES Calculator for Three-Level Blocked Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2 (Random Treatment Effect)*

Description

Minimum detectable effect size calculator for three-level blocked cluster regression discontinuity design where treatment assignment is based on discontinuity at level-2 (random treatment effect).

Usage

```
mdes.bcrd3r2(power=.80, alpha=.05, two.tail=TRUE,
                        rho2, rho3, omega3,
                        RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                        P=.50, g3=0, R12=0, R22=0, RT32=0,
 n, J, K, ...)
```

Arguments

`power`	statistical power (1 - type II error).
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`rho3`	proportion of variance in the outcome explained by level-3 units.
`omega3`	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
`P`	average proportion of level-1 units randomly assigned to treatment within level-2 units.
`RTZ`	correlation between treatment status and assignment variable
`k1`	left truncation point (in standard deviation units from full normal distribution mean).
`k2`	right truncation point (in standard deviation units from full normal distribution mean).
`dist.Z`	distribution of assignment variable; either `normal` or `uniform`.
`g3`	number of covariates at level-3.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`RT32`	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

cosa.bcrd3r2, power.bcrd3r2

Examples

```
## Not run:

        mdes.bcrd3r2(rho3=.15, rho2=.20, omega3=.50, n=10, J=5, K=100)


## End(Not run)
```

---

mdes.bira2c1 *MDES Calculator for Two-Level Constant Effects Blocked Individual Random Assignment Designs, Treatment at Level-1*

Description

mdes.bira2c1 calculates minimum detectable effect size (MDES) for designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (school intercepts only).

Usage

```
mdes.bira2c1(power=.80, alpha=.05, two.tail=TRUE,
             P=.50, g1=0, R12=0,
             n, J, ...)
```

Arguments

power	statistical power $(1-\beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bira2c1, cosa.bira2c1

Examples

```
## Not run:

 mdes.bira2c1(n=55, J=3)


## End(Not run)
```

---

mdes.bira2f1 *MDES Calculator for Two-Level Fixed Effects Blocked Individual Random Assignment Designs, Treatment at Level-1*

Description

mdes.bira2f1 calculates minimum detectable effect size (MDES) for designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (fixed blocks).

Usage

```
mdes.bira2f1(power=.80, alpha=.05, two.tail=TRUE,
             P=.50, g1=0, R12=0,
             n, J, ...)
```

Arguments

power	statistical power $(1-\beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bira2f1, cosa.bira2f1

Examples

```
## Not run:

 mdes.bira2f1(n=55, J=3)


## End(Not run)
```

---

mdes.bira2r1 *MDES Calculator for Two-Level Random Effects Blocked Individual Random Assignment Designs, Individuals Randomized within Blocks*

Description

mdes.bira2r1 calculates minimum detectable effect size (MDES) for designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks).

Usage

```
mdes.bira2r1(power=.80, alpha=.05, two.tail=TRUE,
             rho2, omega2,
             P=.50, g2=0, R12=0, RT22=0,
             n, J, ...)
```

Arguments

power	statistical power $(1-\beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g2	number of covariates at level-2.

R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bira2r1, cosa.bira2r1

Examples

```
## Not run:

 mdes.bira2r1(rho2=.35, omega2=.10,
             n=83, J=480)


## End(Not run)
```

---

mdes.bira3r1 *MDES Calculator for Three-Level Random Effects Blocked Individual Random Assignment Design, Individuals Randomized within Blocks*

Description

mdes.bira3r1 calculates minimum detectable effect size (MDES) for designs with three-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks).

Usage

```
mdes.bira3r1(power=.80, alpha=.05, two.tail=TRUE,
             rho2, rho3, omega2, omega3,
             P=.50, R12=0, RT22=0, RT32=0, g3=0,
             n, J, K, ...)
```

Arguments

power	statistical power $(1 - \beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bira3r1, cosa.bira3r1

Examples

```
## Not run:

 mdes.bira3r1(rho3=.20, rho2=.15, omega3=.10, omega2=.10,
              n=69, J=10, K=100)

## End(Not run)
```

`mdes.bira4r1` *MDES Calculator for Four-Level Random Effects Blocked Individual Random Assignment Design, Individuals Randomized within Blocks*

Description

`mdes.bira4r1` calculates minimum detectable effect size (MDES) for designs with four-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks).

Usage

```
mdes.bira4r1(power=.80, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4, omega2, omega3, omega4,
     P=.50, R12=0, RT22=0, RT32=0, RT42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`rho3`	proportion of variance in the outcome explained by level-3 units.
`rho4`	proportion of variance in the outcome explained by level-4 units.
`omega2`	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
`omega3`	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
`omega4`	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
`P`	average proportion of level-1 units randomly assigned to treatment within level-2 units.
`g4`	number of covariates at level-4.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`RT22`	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
`RT32`	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
`RT42`	proportion of treatment effect variance among level-4 units explained by level-4 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	harmonic mean of level-3 units across level-4 units (or simple average).
`L`	number of level-4 units.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.bira4r1, cosa.bira4r1

Examples

```
## Not run:

  mdes.bira4r1(rho4=.05, rho3=.15, rho2=.15,
              omega4=.50, omega3=.50, omega2=.50,
              n=10, J=4, L=27, K=4)

## End(Not run)
```

---

mdes.bird2f1 *MDES Calculator for Two-Level Blocked Individual Regression Discontinuity Design, Treatment Based on Discontinuity at Level-1 (Fixed Treatment Effect)*

Description

Minimum detectable effect size calculator for two-level blocked individual regression discontinuity design where treatment assignment is based on discontinuity at level-1 (fixed treatment effect).

Usage

```
mdes.bird2f1(power=.80, alpha=.05, two.tail=TRUE,
                          P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
 g1=0, R12=0,
 n, J, ...)
```

Arguments

power	statistical power (1 - type II error).
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).

k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	number of level-2 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

cosa.bird2f1, power.bird2f1

Examples

```
## Not run:

     mdes.bird2f1(n=10, J=100)


## End(Not run)
```

---

mdes.bird2r1 *MDES Calculator for Two-Level Blocked Individual Regression Discontinuity Design, Treatment Based on Discontinuity at Level-1 (Random Treatment Effect)*

Description

Minimum detectable effect size calculator for two-level blocked individual regression discontinuity design where treatment assignment is based on discontinuity at level-1 (random treatment effect).

Usage

```
  mdes.bird2r1(power=.80, alpha=.05, two.tail=TRUE,
rho2, omega2,
P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
g2=0, R12=0, RT22=0, n, J, ...)
```

Arguments

power	statistical power (1 - type II error).
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	number of level-2 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

cosa.bird2r1, power.bird2r1

Examples

```
## Not run:

    mdes.bird2r1(rho2=.20, omega2=.50, n=10, J=100)


## End(Not run)
```

`mdes.cra2r2` *MDES Calculator for Main Effect in Two-Level Cluster Random Assignment Design, Treatment at Level-2*

Description

`mdes.cra2r2` calculates minimum detectable effect size (MDES) for main effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups.

Usage

```
mdes.cra2r2(power=.80, alpha=.05, two.tail=TRUE,
                  rho2,
                  P=.50,  g2=0, R12=0, R22=0,
                  n, J, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`P`	proportion of level-2 units randomly assigned to treatment.
`g2`	number of covariates at level-2.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	level-2 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

`fun`	function name.
`parms`	list of parameters used in MDES calculation.
`ncp`	noncentrality parameter.
`mdes`	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

`power.cra2r2`, `cosa.cra2r2`

Examples

```
## Not run:

 mdes.cra2r2(rho2=.20,
                  n=4, J=20)


## End(Not run)
```

`mdes.cra3r3` *MDES Calculator for Main Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3*

Description

`mdes.cra3r3` calculates minimum detectable effect size (MDES) for main effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups.

Usage

```
mdes.cra3r3(power=.80, alpha=.05, two.tail=TRUE,
                  rho2, rho3, P=.50, g3=0, R12=0, R22=0, R32=0,
                  n, J, K, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`rho3`	proportion of variance in the outcome explained by level-3 units.
`P`	proportion of level-3 units randomly assigned to treatment.
`g3`	number of covariates at level-3.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`R32`	proportion of level-3 variance in the outcome explained by level-3 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

`fun`	function name.
`parms`	list of parameters used in MDES calculation.
`ncp`	noncentrality parameter.
`mdes`	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.cra3r3, cosa.cra3r3

Examples

```
## Not run:

 mdes.cra3r3(rho3=.13, rho2=.10, omega3=.40,
                   n=10, J=6, K=24)


## End(Not run)
```

---

mdes.cra4r4 *MDES Calculator for Four-Level Cluster Random Assignment Designs, Treatment at Level-4*

Description

mdes.cra4r4 calculates minimum detectable effect size (MDES) for designs with four-levels where level-4 units are randomly assigned to treatment and control groups.

Usage

```
mdes.cra4r4(power=.80, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4,
     P=.50, R12=0, R22=0, R32=0, R42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

power	statistical power $(1 - \beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
P	proportion of level-4 units randomly assigned to treatment.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
R42	proportion of level-4 variance in the outcome explained by level-4 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.cra4r4, cosa.cra4r4

Examples

```
## Not run:

  mdes.cra4r4(rho4=.05, rho3=.05, rho2=.10,
              n=10, J=2, K=3, L=20)

## End(Not run)
```

---

mdes.crd2r2 *MDES Calculator for Two-Level Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2*

Description

Minimum detectable effect size calculator for two-level cluster regression discontinuity design where treatment assignment is based on discontinuity at level-2.

Usage

```
mdes.crd2r2(power=.80, alpha=.05, two.tail=TRUE,
                          rho2, P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                          g2=0, R12=0, R22=0,
 n, J, ...)
```

Arguments

power	statistical power (1 - type II error).
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).

dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	number of level-2 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

cosa.crd2r2, power.crd2r2

Examples

```
## Not run:

      mdes.crd2r2(rho2=.20, n=10, J=100)


## End(Not run)
```

---

mdes.crd3r3 *MDES Calculator for Three-Level Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-3*

Description

Minimum detectable effect size calculator for three-level cluster regression discontinuity design where treatment assignment is based on discontinuity at level-3.

Usage

```
mdes.crd3r3(power=.80, alpha=.05, two.tail=TRUE,
                    rho2, rho3, P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                         g3=0, R12=0, R22=0, R32=0,
 n, J, K, ...)
```

Arguments

power	statistical power (1 - type II error).
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

cosa.crd3r3, power.crd3r3

Examples

```
## Not run:

      mdes.crd3r3(rho2=.20, rho3=.10, n=10, J=5, K=100)


## End(Not run)
```

`mdes.ira1r1` *MDES Calculator for Individual Random Assignment Designs, Completely Randomized Controlled Trials*

Description

`mdes.ira1r1` calculates minimum detectable effect size (MDES) for completely randomized controlled trials where individuals are randomly assigned to treatment or control groups.

Usage

```
mdes.ira1r1(power=.80, alpha=.05, two.tail=TRUE,
            P=.50, g1=0, R12=0,
            n, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`P`	proportion of units randomly assigned to treatment.
`g1`	number of covariates.
`R12`	proportion of variance in the outcome explained by covariates.
`n`	sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

`fun`	function name.
`parms`	list of parameters used in MDES calculation.
`ncp`	noncentrality parameter.
`mdes`	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

`power.ira1r1`, `cosa.ira1r1`

Examples

```
## Not run:

 mdes.ira1r1(n=55)


## End(Not run)
```

`mdes.ird1r1` *MDES Calculator for Main Effect in Individual Regression Discontinuity Design*

Description

`mdes.ird1r1` calculates minimum detectable effect size for main effect in individual regression discontinuity design where treatment assignment is based on discontinuity at the individual level.

Usage

```
mdes.ird1r1(power=.80, alpha=.05, two.tail=TRUE,
                    P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                    g1=0, R12=0,
 n, ...)
```

Arguments

`power`	statistical power (1 - type II error).
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`P`	average proportion of units randomly assigned to treatment.
`RTZ`	correlation between treatment status and assignment variable.
`k1`	left truncation point (in standard deviation units from full normal distribution mean).
`k2`	right truncation point (in standard deviation units from full normal distribution mean).
`dist.Z`	distribution of assignment variable; either `normal` or `uniform`.
`g1`	number of covariates.
`R12`	proportion of variance in the outcome explained by covariates.
`n`	sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

`fun`	function name.
`parms`	list of parameters used in MDES calculation.
`ncp`	noncentrality parameter.
`mdes`	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

`cosa.ird1r1`, `power.ird1r1`

Examples

```
## Not run:

    mdes.ird1r1(n=100)


## End(Not run)
```

`mdes.mod1n.cra2r2` *MDES Calculator for Non-Randomly Varying Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment at Level-2, Moderator at Level-1*

Description

`mdes.mod1n.cra2r2` calculates minimum detectable effect size (MDES) for non-randomly varying moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
mdes.mod1n.cra2r2(power=.80, alpha=.05, two.tail=TRUE,
                  rho2, P=.50, Q=NULL, g1=0, R12=0,
                  n, J, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`P`	proportion of level-2 units randomly assigned to treatment.
`Q`	proportion of level-1 units within moderator subgroup. `NULL` implies continuous moderator.
`g1`	number of covariates at level-1 excluding moderator.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	level-2 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

`fun`	function name.
`parms`	list of parameters used in MDES calculation.
`ncp`	noncentrality parameter.
`mdes`	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.mod1n.cra2r2, cosa.mod1n.cra2r2

Examples

```
## Not run:

 mdes.mod1n.cra2r2(rho2=.20,
                   n=4, J=20)


## End(Not run)
```

---

mdes.mod1n.cra3r3 *MDES Calculator for Non-Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Design, Treatment at Level-3, Moderator at Level-1*

Description

mdes.mod1n.cra3r3 calculates minimum detectable effect size (MDES) for non-randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
 mdes.mod1n.cra3r3(power=.80, alpha=.05, two.tail=TRUE,
                   rho2, rho3, P=.50, Q=NULL, g1=0, R12=0,
                   n, J, K, ...)
```

Arguments

power	statistical power $(1 - \beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.mod1n.cra3r3, cosa.mod1n.cra3r3

Examples

```
## Not run:

 mdes.mod1n.cra3r3(rho3=.13, rho2=.10, omega3=.40,
                   n=10, J=6, K=24)


## End(Not run)
```

---

mdes.mod1r.cra2r2 *MDES Calculator for Randomly Varying Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment at Level-2, Moderator at Level-1*

Description

mdes.mod1r.cra2r2 calculates minimum detectable effect size (MDES) for randomly varying moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
mdes.mod1r.cra2r2(power=.80, alpha=.05, two.tail=TRUE,
                  rho2, omega2, RT22=0, P=.50, Q=NULL, g1=0, R12=0,
                  n, J, ...)
```

Arguments

power	statistical power $(1-\beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	moderator effect heterogeneity (unconditional) across level-2 units.
P	proportion of level-2 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.

g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of level-2 variance in the moderator effect explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.mod1r.cra2r2, cosa.mod1r.cra2r2

Examples

```
## Not run:

 mdes.mod1r.cra2r2(rho2=.2, omega2=.2, RT22=.2, n=4, J=20)


## End(Not run)
```

---

mdes.mod1r.cra3r3 *MDES Calculator for Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3, Moderator at Level-1*

Description

mdes.mod1r.cra3r3 calculates minimum detectable effect size (MDES) for randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
mdes.mod1r.cra3r3(power=.80, alpha=.05, two.tail=TRUE,
                    rho2, rho3, omega2, omega3, P=.50, Q=NULL,
                    g1=0, R12=0, RT22=0, RT32=0,
                    n, J, K, ...)
```

Arguments

power	statistical power $(1 - \beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega2	moderator effect heterogeneity (unconditional) across level-2 units.
omega3	moderator effect heterogeneity (unconditional) across level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of level-2 variance in the moderator effect explained by level-2 covariates.
RT32	proportion of level-3 variance in the moderator effect explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.mod1r.cra3r3, cosa.mod1r.cra3r3

Examples

```
## Not run:

  mdes.mod1r.cra3r3(rho3=.05, rho2=.12, omega2=.08, omega3=.07,
                    P=.4, Q=.7, g1=1, R12=.20, RT22=0, RT32=0,
                    n=20, J=4, K=60)


## End(Not run)
```

`mdes.mod2.cra2r2` *MDES Calculator for Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment and Moderator at Level-2*

Description

`mdes.mod2.cra2r2` calculates minimum detectable effect size (MDES) for moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-2.

Usage

```
mdes.mod2.cra2r2(power=.80, alpha=.05, two.tail=TRUE,
                 rho2, P=.50, Q=NULL, g2=0, R12=0, R22=0,
                 n, J, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`P`	proportion of level-2 units randomly assigned to treatment.
`Q`	proportion of level-1 units within moderator subgroup. `NULL` implies continuous moderator.
`g2`	number of covariates at level-2 excluding moderator.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	level-2 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

`fun`	function name.
`parms`	list of parameters used in MDES calculation.
`ncp`	noncentrality parameter.
`mdes`	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

`power.mod2.cra2r2`, `cosa.mod2.cra2r2`

Examples

```
## Not run:

 mdes.mod2.cra2r2(rho2=.20, n=4, J=20, Q=.5)


## End(Not run)
```

`mdes.mod2n.cra3r3` *MDES Calculator for Non-Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Design, Treatment at Level-3, Moderator at Level-2*

Description

`mdes.mod2n.cra3r3` calculates minimum detectable effect size (MDES) for non-randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-2.

Usage

```
mdes.mod2n.cra3r3(power=.80, alpha=.05, two.tail=TRUE,
                  rho2, rho3, P=.50, Q=NULL, g2=0, R12=0, R22=0,
                  n, J, K, ...)
```

Arguments

`power`	statistical power $(1 - \beta)$.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`rho3`	proportion of variance in the outcome explained by level-3 units.
`P`	proportion of level-3 units randomly assigned to treatment.
`Q`	proportion of level-1 units within moderator subgroup. `NULL` implies continuous moderator.
`g2`	number of covariates at level-2 excluding moderator.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.mod2n.cra3r3, cosa.mod2n.cra3r3

Examples

```
## Not run:

  mdes.mod2n.cra3r3(rho3=.10, rho2=.10, Q=.5, g2=1,
                    R12=.30, R22=.40,  n=20, J=4, K=60)


## End(Not run)
```

---

mdes.mod2r.cra3r3 *MDES Calculator for Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3, Moderator at Level-2*

Description

mdes.mod2r.cra3r3 calculates minimum detectable effect size (MDES) for randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-2.

Usage

```
mdes.mod2r.cra3r3(power=.80, alpha=.05, two.tail=TRUE,
                  rho2, rho3, omega3, P=.50, Q=NULL, g2=0, R12=0, R22=0, RT32=0,
                    n, J, K, ...)
```

Arguments

power	statistical power $(1-\beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega3	moderator effect heterogeneity (unconditional) across level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.

g2	number of covariates at level-2 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of level-3 variance in the moderator effect explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.mod2r.cra3r3, cosa.mod2r.cra3r3

Examples

```
## Not run:

  mdes.mod2r.cra3r3(rho3=.10, rho2=.10, omega3=.05, Q=.5, g2=1,
                    R12=.30, R22=.40, RT32=0,  n=20, J=4, K=60)


## End(Not run)
```

---

mdes.mod3.cra3r3 *MDES Calculator for Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment and Moderator at Level-3*

Description

mdes.mod3.cra3r3 calculates minimum detectable effect size (MDES) for moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-3.

Usage

```
mdes.mod3.cra3r3(power=.80, alpha=.05, two.tail=TRUE,
                  rho2, rho3, P=.50, Q=NULL, g3=0, R12=0, R22=0, R32=0,
                  n, J, K, ...)
```

Arguments

power	statistical power $(1 - \beta)$.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g3	number of covariates at level-3 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in MDES calculation.
ncp	noncentrality parameter.
mdes	minimum detectable effect size and $(1-\alpha)\%$ lower and upper confidence limits.

See Also

power.mod3.cra3r3, cosa.mod3.cra3r3

Examples

```
## Not run:

  mdes.mod3.cra3r3(rho3=.1, rho2=.1, omega3=.05, Q=.5,
                   g3=1, R12=.3, R22=.4, R32=.5, n=20, J=4, K=60)


## End(Not run)
```

mdes.to.pctl *MDES to Percentiles*

Description

mdes.to.pctl converts MDES values returned from mdes function into percentile values.

Usage

```
mdes.to.pctl(x)
```

Arguments

x	an object returned from mdes function or a numeric value in standard deviation units.

Details

mdes.to.pctl converts MDES values returned from mdes function into percentile values. Values should be interpreted as percentile increase with reference to 50th percentile.

See Also

cosa.to.mdes

Examples

```
## Not run:

  # MDES values returned from mdes function
  design1 <- mdes.cra3r3(power=.80, rho2=.06, rho3=.18,
                    g3=1, R12=.55, R22=.50, R32=.45,
                    P=.40, n=10, J=2, K=83)
  # convert MDES values into percentiles
  percentiles <- mdes.to.pctl(design1)


## End(Not run)
```

mdes.to.power *MDES to power*

Description

mdes.to.power converts an object returned from mdes function into an object returned from power function.

Usage

```
mdes.to.power(x)
```

Arguments

x	an object returned from one of the mdes functions.

Details

mdes.to.power converts an object returned from mdes function into an object returned from power function by passing parameters through power function.

See Also

cosa.to.mdes, power.to.mdes

Examples

```
## Not run:

  # object returned from power function
  design1 <- mdes.bira2r1(rho2=.35, omega2=.10, n=83, J=10)
  # convert the object into an object returned from mdes function
  design2 <- mdes.to.power(design1)


## End(Not run)
```

---

power.bcra3f2 *Statistical Power Calculator for Three-Level Fixed Effects Blocked Cluster Random Assignment Design, Treatment at Level-2*

Description

power.bcra3f2 calculates statistical power for designs with three-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (fixed blocks).

Usage

```
power.bcra3f2(mdes=.25, alpha=.05, two.tail=TRUE,
     rho2,
     P=.50, g2=0, R12=0, R22=0,
     n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	average proportion of level-2 units randomly assigned to treatment within level-3 units.
g2	number of covariates at level-2.

R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bcra3f2, cosa.bcra3f2

Examples

```
## Not run:

    power.bcra3f2(rho2=.10,
                  n=20, J=44, K=5)


## End(Not run)
```

---

power.bcra3r2 *Statistical Power Calculator for Three-Level Random Effects Blocked Cluster Random Assignment Designs, Treatment at Level-2*

Description

power.bcra3r2 calculates statistical power for designs with three-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (random blocks).

Usage

```
power.bcra3r2(mdes=.25, alpha=.05, two.tail=TRUE,
     rho2, rho3, omega3,
     P=.50, g3=0, R12=0, R22=0, RT32=0,
     n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
P	average proportion of level-2 units randomly assigned to treatment within level-3 units.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bcra3r2, cosa.bcra3r2

Examples

```
## Not run:

    power.bcra3r2(rho3=.13, rho2=.10, omega3=.40,
                  n=10, J=6, K=24)


## End(Not run)
```

power.bcra4f3 *Statistical Power Calculator for Four-Level Fixed Effects Blocked Cluster Random Assignment Designs, Treatment at Level-3*

Description

power.bcra4f3 calculates statistical power for designs with four-levels where level-3 units are randomly assigned to treatment and control groups within level-4 units (fixed blocks).

Usage

```
power.bcra4f3(mdes=.25, alpha=.05, two.tail=TRUE,
     rho2, rho3,
     P=.50, R12=0, R22=0, R32=0, g3=0,
     n, J, K, L, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	average proportion of level-3 units randomly assigned to treatment within level-4 units.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bcra4f3, cosa.bcra4f3

Examples

```
## Not run:

    power.bcra4f3(rho3=.15, rho2=.15,
                  n=10, J=4, K=4, L=15)


## End(Not run)
```

`power.bcra4r2` *Statistical Power Calculator for Four-Level Random Effects Block Random Assignment Designs, Treatment at Level-2*

Description

`power.bcra4r2` calculates statistical power for designs with four-levels where level-2 units are randomly assigned to treatment and control groups within level-3 units (random blocks).

Usage

```
power.bcra4r2(mdes=.25, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4, omega3, omega4,
     P=.50, R12=0, R22=0, RT32=0, RT42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`rho3`	proportion of variance in the outcome explained by level-3 units.
`rho4`	proportion of variance in the outcome explained by level-4 units.
`omega3`	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
`omega4`	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
`P`	average proportion of level-2 units randomly assigned to treatment within level-3 units.
`g4`	number of covariates at level-4.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`RT32`	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
`RT42`	proportion of treatment effect variance among level-4 units explained by level-4 covariates.

n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bcra4r2, cosa.bcra4r2

Examples

```
## Not run:

    power.bcra4r2(rho4=.05, rho3=.15, rho2=.15,
                  omega4=.50, omega3=.50,
                  n=10, J=4, L=27, K=4)

## End(Not run)
```

---

power.bcra4r3 *Statistical Power Calculator for Four-Level Random Effects Blocked Cluster Random Assignment Designs, Treatment at Level-3*

Description

power.bcra4r3 calculates statistical power for designs with four-levels where level-3 units are randomly assigned to treatment and control groups within level-4 units (random blocks).

Usage

```
power.bcra4r3(mdes=.25, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4, omega4,
     P=.50, R12=0, R22=0, R32=0, RT42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
omega4	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
P	average proportion of level-3 units randomly assigned to treatment within level-4 units.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
RT42	proportion of treatment effect variance among level-4 units explained by level-4 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bcra4r3, cosa.bcra4r3

Examples

```
## Not run:

    power.bcra4r3(rho4=.05, rho3=.15, rho2=.15,
                  omega4=.50,
                  n=10, J=4, L=27, K=4)

## End(Not run)
```

power.bcrd3f2 *Statistical Power Calculator for Three-Level Blocked Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2 (Fixed Treatment Effect)*

Description

Statistical power calculator for three-level blocked cluster regression discontinuity design where treatment assignment is based on discontinuity at level-2 (fixed treatment effect).

Usage

```
power.bcrd3f2(mdes=.25, alpha=.05, two.tail=TRUE,
                        rho2, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                        P=.50, g2=0, R12=0, R22=0,
 n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$

See Also

cosa.bcrd3f2, mdes.bcrd3f2

Examples

```
## Not run:

      mdes.bcrd3f2(rho2=.20, n=10, J=5, K=100)


## End(Not run)
```

---

power.bcrd3r2 *Statistical Power Calculator for Three-Level Blocked Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2 (Random Treatment Effect)*

Description

Statistical power calculator for three-level blocked cluster regression discontinuity design where treatment assignment is based on discontinuity at level-2 (random treatment effect).

Usage

```
power.bcrd3r2(mdes=.25, alpha=.05, two.tail=TRUE,
                        rho2, rho3, omega3,
                        RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                        P=.50, g3=0, R12=0, R22=0, RT32=0,
 n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.

g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$

See Also

cosa.bcrd3r2, mdes.bcrd3r2

Examples

```
## Not run:

        power.bcrd3r2(rho3=.15, rho2=.20, omega3=.50, n=10, J=5, K=100)


## End(Not run)
```

---

power.bira2c1 *Statistical Power Calculator for Two-Level Constant Effects Blocked Individual Random Assignment Designs, Treatment at Level-1*

Description

power.bira2c1 calculates statistical power for designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (school intercepts only).

Usage

```
power.bira2c1(mdes=.25, alpha=.05, two.tail=TRUE,
              P=.50, g1=0, R12=0,
              n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bira2c1, cosa.bira2c1

Examples

```
## Not run:

   power.bira2c1(n=55, J=3)


## End(Not run)
```

---

power.bira2f1 *Statistical Power Calculator for Two-Level Fixed Effects Blocked Individual Random Assignment Designs, Treatment at Level-1*

Description

power.bira2f1 calculates statistical power for designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (fixed blocks).

Usage

```
power.bira2f1(mdes=.25, alpha=.05, two.tail=TRUE,
              P=.50, g1=0, R12=0,
              n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bira2f1, cosa.bira2f1

Examples

```
## Not run:

   power.bira2f1(n=55, J=3)


## End(Not run)
```

---

power.bira2r1 *Statistical Power Calculator for Two-Level Random Effects Blocked Individual Random Assignment Designs, Individuals Randomized within Blocks*

Description

power.bira2r1 calculates statistical power for designs with two-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks).

Usage

```
power.bira2r1(mdes=.25, alpha=.05, two.tail=TRUE,
              rho2, omega2,
              g2=0, P=.50, R12=0, RT22=0,
              n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bira2r1, cosa.bira2r1

Examples

```
## Not run:

   power.bira2r1(rho2=.35, omega2=.10,
               n=83, J=480)


## End(Not run)
```

power.bira3r1 *Statistical Power Calculator for Three-Level Random Effects Blocked Individual Random Assignment Design, Individuals Randomized within Blocks*

Description

power.bira3r1 calculates statistical power for designs with three-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks).

Usage

```
power.bira3r1(mdes=.25, alpha=.05, two.tail=TRUE,
              rho2, rho3, omega2, omega3,
              P=.50, R12=0, RT22=0, RT32=0, g3=0,
              n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bira3r1, cosa.bira3r1

Examples

```
## Not run:

    power.bira3r1(rho3=.20, rho2=.15, omega3=.10, omega2=.10,
                  n=69, J=10, K=100)

## End(Not run)
```

---

power.bira4r1 *Statistical Power Calculator for Four-Level Random Effects Blocked Individual Random Assignment Design, Individuals Randomized within Blocks*

Description

power.bira4r1 calculates statistical power for designs with four-levels where level-1 units are randomly assigned to treatment and control groups within level-2 units (random blocks).

Usage

```
power.bira4r1(mdes=.25, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4, omega2, omega3, omega4,
     P=.50, R12=0, RT22=0, RT32=0, RT42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
omega3	treatment effect heterogeneity as ratio of treatment effect variance among level-3 units to the residual variance at level-3.
omega4	treatment effect heterogeneity as ratio of treatment effect variance among level-4 units to the residual variance at level-4.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.

RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
RT32	proportion of treatment effect variance among level-3 units explained by level-3 covariates.
RT42	proportion of treatment effect variance among level-4 units explained by level-4 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.bira4r1, cosa.bira4r1

Examples

```
## Not run:

    power.bira4r1(rho4=.05, rho3=.15, rho2=.15,
                  omega4=.50, omega3=.50, omega2=.50,
                  n=10, J=4, L=27, K=4)

## End(Not run)
```

---

power.bird2f1 *Statistical Power Calculator for Two-Level Blocked Individual Regression Discontinuity Design, Treatment Based on Discontinuity at Level-1 (Fixed Treatment Effect)*

Description

Statistical power calculator for two-level blocked individual regression discontinuity design where treatment assignment is based on discontinuity at level-1 (fixed treatment effect).

Usage

```
power.bird2f1(mdes=.25, alpha=.05, two.tail=TRUE,
                         P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
 g1=0, R12=0,
 n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g1	number of covariates at level-1.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	number of level-2 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$

See Also

cosa.bird2f1, mdes.bird2f1

Examples

```
## Not run:

     power.bird2f1(n=10, J=100)


## End(Not run)
```

power.bird2r1 *Statistical Power Calculator for Two-Level Blocked Individual Regression Discontinuity Design, Treatment Based on Discontinuity at Level-1 (Random Treatment Effect)*

Description

Statistical power calculator for two-level blocked individual regression discontinuity design where treatment assignment is based on discontinuity at level-1 (random treatment effect).

Usage

```
  power.bird2r1(mdes=.25, alpha=.05, two.tail=TRUE,
rho2, omega2, g2=0,
P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
R12=0, RT22=0, n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	treatment effect heterogeneity as ratio of treatment effect variance among level-2 units to the residual variance at level-2.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of treatment effect variance among level-2 units explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	number of level-2 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$

See Also

cosa.bird2r1, mdes.bird2r1

Examples

```
## Not run:

    power.bird2r1(rho2=.20, omega2=.50, n=10, J=100)


## End(Not run)
```

---

power.cra2r2 *Statistical Power Calculator for Main Effect in Two-Level Cluster Random Assignment Design, Treatment at Level-2*

Description

power.cra2r2 calculates statistical power for main effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups.

Usage

```
power.cra2r2(mdes=.25, alpha=.05, two.tail=TRUE,
                  rho2, g2=0, P=.50, R12=0, R22=0,
                  n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	proportion of level-2 units randomly assigned to treatment.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.cra2r2, cosa.cra2r2

Examples

```
## Not run:

   power.cra2r2(rho2=.20, n=4, J=20)


## End(Not run)
```

---

power.cra3r3 *Statistical Power Calculator for Main Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3*

Description

power.cra3r3 calculates statistical power for main effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups.

Usage

```
power.cra3r3(mdes=.25, alpha=.05, two.tail=TRUE,
             rho2, rho3,
             P=.50, g3=0, R12=0, R22=0, R32=0,
             n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.

n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.cra3r3, cosa.cra3r3

Examples

```
## Not run:

    power.cra3r3(rho3=.06, rho2=.17,
                        n=15, J=3, K=60)


## End(Not run)
```

---

power.cra4r4 *Statistical Power Calculator for Four-Level Cluster Random Assignment Designs, Treatment at Level-4*

Description

power.cra4r4 calculates statistical power for designs with four-levels where level-4 units are randomly assigned to treatment and control groups.

Usage

```
power.cra4r4(mdes=.25, alpha=.05, two.tail=TRUE,
     rho2, rho3, rho4,
     P=.50, R12=0, R22=0, R32=0, R42=0, g4=0,
     n, J, K, L, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.

rho3	proportion of variance in the outcome explained by level-3 units.
rho4	proportion of variance in the outcome explained by level-4 units.
P	proportion of level-4 units randomly assigned to treatment.
g4	number of covariates at level-4.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
R42	proportion of level-4 variance in the outcome explained by level-4 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	harmonic mean of level-3 units across level-4 units (or simple average).
L	number of level-4 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.cra4r4, cosa.cra4r4

Examples

```
## Not run:

    power.cra4r4(rho4=.05, rho3=.05, rho2=.10,
                 n=10, J=2, K=3, L=20)


## End(Not run)
```

---

power.crd2r2 *Statistical Power Calculator for Two-Level Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-2*

Description

Statistical power calculator for two-level cluster regression discontinuity design where treatment assignment is based on discontinuity at level-2.

Usage

```
power.crd2r2(mdes=.25, alpha=.05, two.tail=TRUE,
                    rho2, g2=0, P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                         R12=0, R22=0,
 n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g2	number of covariates at level-2.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	number of level-2 units.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$

See Also

cosa.crd2r2, mdes.crd2r2

Examples

```
## Not run:

     power.crd2r2(rho2=.20, n=10, J=100)


## End(Not run)
```

power.crd3r3 *Statistical Power Calculator for Three-Level Cluster Regression Discontinuity Design, Treatment Based on Discontinuity at Level-3*

Description

Statistical power calculator for three-level cluster regression discontinuity design where treatment assignment is based on discontinuity at level-3.

Usage

```
power.crd3r3(mdes=.25, alpha=.05, two.tail=TRUE,
                    rho2, rho3, P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                         g3=0, R12=0, R22=0, R32=0,
 n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	average proportion of level-1 units randomly assigned to treatment within level-2 units.
RTZ	correlation between treatment status and assignment variable
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g3	number of covariates at level-3.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$

See Also

cosa.crd3r3, mdes.crd3r3

Examples

```
## Not run:

      power.crd3r3(rho2=.20, rho3=.10, n=10, J=5, K=100)


## End(Not run)
```

---

power.ira1r1 *Statistical Power Calculator for Individual Random Assignment Designs, Completely Randomized Controlled Trials*

Description

power.ira1r1 calculates statistical power for completely randomized controlled trials where individuals are randomly assigned to treatment or control groups.

Usage

```
power.ira1r1(mdes=.25, alpha=.05, two.tail=TRUE,
             P=.50, g1=0, R12=0,
             n, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	proportion of units randomly assigned to treatment.
g1	number of covariates.
R12	proportion of variance in the outcome explained by covariates.
n	sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.ira1r1, cosa.ira1r1

Examples

```
## Not run:

   power.ira1r1(n=55)


## End(Not run)
```

---

power.ird1r1 *Statistical Power Calculator for Main Effect in Individual Regression Discontinuity Design*

Description

power.ird1r1 calculates statistical power for main effect in individual regression discontinuity design where treatment assignment is based on discontinuity at the individual level.

Usage

```
power.ird1r1(mdes=.25, alpha=.05, two.tail=TRUE,
                     P=.50, RTZ=NULL, k1=-6, k2=6, dist.Z="normal",
                     g1=0, R12=0,
 n, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
P	average proportion of units randomly assigned to treatment.
RTZ	correlation between treatment status and assignment variable.
k1	left truncation point (in standard deviation units from full normal distribution mean).
k2	right truncation point (in standard deviation units from full normal distribution mean).
dist.Z	distribution of assignment variable; either normal or uniform.
g1	number of covariates.
R12	proportion of variance in the outcome explained by covariates.
n	sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$

See Also

cosa.ird1r1, mdes.ird1r1

Examples

```
## Not run:

    power.ird1r1(n=100)


## End(Not run)
```

---

power.mod1n.cra2r2 *Statistical Power Calculator for for Non-Randomly Varying Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment at Level-2, Moderator at Level-1*

Description

power.mod1n.cra2r2 calculates statistical power for non-randomly varying moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
power.mod1n.cra2r2(mdes=.25, alpha=.05, two.tail=TRUE,
                   rho2, P=.50, Q=NULL, g1=0, R12=0,
                   n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	proportion of level-2 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.

R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.mod1n.cra2r2, cosa.mod1n.cra2r2

Examples

```
## Not run:

   power.mod1n.cra2r2(rho2=.20, n=4, J=20)


## End(Not run)
```

---

power.mod1n.cra3r3 *Statistical Power Calculator for Non-Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Design, Treatment at Level-3, Moderator at Level-1*

Description

power.mod1n.cra3r3 calculates statistical power for non-randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
power.mod1n.cra3r3(mdes=.25, alpha=.05, two.tail=TRUE,
                   rho2, rho3, P=.50, Q=NULL, g1=0, R12=0,
                   n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.

rho3	proportion of variance in the outcome explained by level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.mod1n.cra3r3, cosa.mod1n.cra3r3

Examples

```
## Not run:

    power.mod1n.cra3r3(rho3=.06, rho2=.17,
                       n=15, J=3, K=60)


## End(Not run)
```

---

power.mod1r.cra2r2 *Statistical Power Calculator for Randomly Varying Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment at Level-2, Moderator at Level-1*

Description

power.mod1r.cra2r2 calculates statistical power for randomly varying moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
power.mod1r.cra2r2(mdes=.25, alpha=.05, two.tail=TRUE,
                   rho2, omega2, RT22=0, P=.50, Q=NULL, g1=0, R12=0,
                   n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
omega2	moderator effect heterogeneity (unconditional) across level-2 units.
P	proportion of level-2 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g1	number of covariates at level-1 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
RT22	proportion of level-2 variance in the moderator effect explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.mod1r.cra2r2, cosa.mod1r.cra2r2

Examples

```
## Not run:

   power.mod1r.cra2r2(rho2=.2, omega2=.2, RT22=.2, n=4, J=20)


## End(Not run)
```

`power.mod1r.cra3r3` *Statistical Power Calculator for Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3, Moderator at Level-1*

Description

`power.mod1r.cra3r3` calculates statistical power for randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-1.

Usage

```
power.mod1r.cra3r3(mdes=.25, alpha=.05, two.tail=TRUE,
                   rho2, rho3, omega2, omega3, P=.50, Q=NULL,
                   g1=0, R12=0, RT22=0, RT32=0,
                   n, J, K, ...)
```

Arguments

`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`rho3`	proportion of variance in the outcome explained by level-3 units.
`omega2`	moderator effect heterogeneity (unconditional) across level-2 units.
`omega3`	moderator effect heterogeneity (unconditional) across level-3 units.
`P`	proportion of level-3 units randomly assigned to treatment.
`Q`	proportion of level-1 units within moderator subgroup. `NULL` implies continuous moderator.
`g1`	number of covariates at level-1 excluding moderator.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`RT22`	proportion of level-2 variance in the moderator effect explained by level-2 covariates.
`RT32`	proportion of level-3 variance in the moderator effect explained by level-3 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.mod1r.cra3r3, cosa.mod1r.cra3r3

Examples

```
## Not run:

    power.mod1r.cra3r3(rho3=.05, rho2=.12, omega2=.08, omega3=.07,
                       P=.4, Q=.7, g1=1, R12=.20, RT22=0, RT32=0,
                       n=20, J=4, K=60)


## End(Not run)
```

---

power.mod2.cra2r2 *Statistical Power Calculator for Moderator Effect in Two-Level Cluster Random Assignment Design, Treatment and Moderator at Level-2*

Description

power.mod2.cra2r2 calculates statistical power for moderator effect in designs with two-levels where level-2 units are randomly assigned to treatment and control groups and moderator is at level-2.

Usage

```
power.mod2.cra2r2(mdes=.25, alpha=.05, two.tail=TRUE,
                  rho2, P=.50, Q=NULL, g2=0, R12=0, R22=0,
                  n, J, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
P	proportion of level-2 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g2	number of covariates at level-2 excluding moderator.

R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	level-2 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.mod2.cra2r2, cosa.mod2.cra2r2

Examples

```
## Not run:

   power.mod2.cra2r2(rho2=.20, n=4, J=20, Q=.5)


## End(Not run)
```

---

power.mod2n.cra3r3 *Statistical Power Calculator for Non-Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Design, Treatment at Level-3, Moderator at Level-2*

Description

power.mod2n.cra3r3 calculates statistical power for non-randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-2.

Usage

```
power.mod2n.cra3r3(mdes=.25, alpha=.05, two.tail=TRUE,
                   rho2, rho3, P=.50, Q=NULL, g2=0, R12=0, R22=0,
                   n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g2	number of covariates at level-2 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.mod2n.cra3r3, cosa.mod2n.cra3r3

Examples

```
## Not run:

     power.mod2n.cra3r3(rho3=.10, rho2=.10, Q=.5, g2=1,
                        R12=.30, R22=.40,  n=20, J=4, K=60)


## End(Not run)
```

`power.mod2r.cra3r3` *Statistical Power Calculator for Randomly Varying Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment at Level-3, Moderator at Level-2*

Description

`power.mod2r.cra3r3` calculates statistical power for randomly varying moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-2.

Usage

```
power.mod2r.cra3r3(mdes=.25, alpha=.05, two.tail=TRUE,
                rho2, rho3, omega3, P=.50, Q=NULL, g2=0, R12=0, R22=0, RT32=0,
                    n, J, K, ...)
```

Arguments

`mdes`	minimum detectable effect size.
`alpha`	probability of type I error.
`two.tail`	logical; `TRUE` for two-tailed hypothesis testing, `FALSE` for one-tailed hypothesis testing.
`rho2`	proportion of variance in the outcome explained by level-2 units.
`rho3`	proportion of variance in the outcome explained by level-3 units.
`omega3`	moderator effect heterogeneity (unconditional) across level-3 units.
`P`	proportion of level-3 units randomly assigned to treatment.
`Q`	proportion of level-1 units within moderator subgroup. `NULL` implies continuous moderator.
`g2`	number of covariates at level-2 excluding moderator.
`R12`	proportion of level-1 variance in the outcome explained by level-1 covariates.
`R22`	proportion of level-2 variance in the outcome explained by level-2 covariates.
`RT32`	proportion of level-3 variance in the moderator effect explained by level-3 covariates.
`n`	harmonic mean of level-1 units across level-2 units (or simple average).
`J`	harmonic mean of level-2 units across level-3 units (or simple average).
`K`	level-3 sample size.
`...`	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

`fun`	function name.
`parms`	list of parameters used in power calculation.
`ncp`	noncentrality parameter.
`power`	statistical power $(1 - \beta)$.

See Also

mdes.mod2r.cra3r3, cosa.mod2r.cra3r3

Examples

```
## Not run:

    power.mod2r.cra3r3(rho3=.10, rho2=.10, omega3=.05, Q=.5, g2=1,
                       R12=.30, R22=.40, RT32=0,  n=20, J=4, K=60)


## End(Not run)
```

---

power.mod3.cra3r3 *Statistical Power Calculator for Moderator Effect in Three-Level Cluster Random Assignment Designs, Treatment and Moderator at Level-3*

Description

power.mod3.cra3r3 calculates statistical power for moderator effect in designs with three-levels where level-3 units are randomly assigned to treatment and control groups and moderator is at level-3.

Usage

```
power.mod3.cra3r3(mdes=.25, alpha=.05, two.tail=TRUE,
                  rho2, rho3, P=.50, Q=NULL, g3=0, R12=0, R22=0, R32=0,
                  n, J, K, ...)
```

Arguments

mdes	minimum detectable effect size.
alpha	probability of type I error.
two.tail	logical; TRUE for two-tailed hypothesis testing, FALSE for one-tailed hypothesis testing.
rho2	proportion of variance in the outcome explained by level-2 units.
rho3	proportion of variance in the outcome explained by level-3 units.
P	proportion of level-3 units randomly assigned to treatment.
Q	proportion of level-1 units within moderator subgroup. NULL implies continuous moderator.
g3	number of covariates at level-3 excluding moderator.
R12	proportion of level-1 variance in the outcome explained by level-1 covariates.
R22	proportion of level-2 variance in the outcome explained by level-2 covariates.
R32	proportion of level-3 variance in the outcome explained by level-3 covariates.
n	harmonic mean of level-1 units across level-2 units (or simple average).
J	harmonic mean of level-2 units across level-3 units (or simple average).
K	level-3 sample size.
...	to handle extra parameters passed from other functions, do not define any additional parameters.

Value

fun	function name.
parms	list of parameters used in power calculation.
ncp	noncentrality parameter.
power	statistical power $(1 - \beta)$.

See Also

mdes.mod3.cra3r3, cosa.mod3.cra3r3

Examples

```
## Not run:

    power.mod3.cra3r3(rho3=.1, rho2=.1, omega3=.05, Q=.5,
                  g3=1, R12=.3, R22=.4, R32=.5, n=20, J=4, K=60)


## End(Not run)
```

---

power.to.mdes *power to MDES*

Description

power.to.mdes converts an object returned from power function into an object returned from mdes function.

Usage

```
power.to.mdes(x)
```

Arguments

x	an object returned from one of the power functions.

Details

power.to.mdes converts an object returned from power function into an object returned from mdes function by passing parameters through mdes function.

See Also

cosa.to.mdes

Examples

```
## Not run:

  # object returned from power function
  design1 <- power.bira2r1(mdes=.15, rho2=.35, omega2=.10, n=83, J=10)
  # convert the object into an object returned from mdes function
  design2 <- power.to.mdes(design1)


## End(Not run)
```

PowerUpR-deprecated *Deprecated and Defunct functions in 'PowerUpR'*

Description

Deprecated functions are provided for compatibility purposes and will be defunct in the next 'PowerUpR' release. Defunct functions are no longer supported.

Format

Deprecated functions are no longer documented, please use documentation for new functions.

Details

Deprecated and defunct functions and their replacement are as follows:

- `mrss.ira1r1` is deprecated, use `cosa.ira1r1`
- `mrss.cra2r2` is deprecated, use `cosa.cra2r2`
- `mrss.cra3r3` is deprecated, use `cosa.cra3r3`
- `mrss.cra4r4` is deprecated, use `cosa.cra4r4`
- `mrss.bcra3f2` is deprecated, use `cosa.bcra3f2`
- `mrss.bcra3r2` is deprecated, use `cosa.bcra3r2`
- `mrss.bcra4r2` is deprecated, use `cosa.bcra4r2`
- `mrss.bcra4f3` is deprecated, use `cosa.bcra4f3`
- `mrss.bcra4r2` is deprecated, use `cosa.bcra4r2`
- `mrss.bira4r1` is deprecated, use `cosa.bira4r1`
- `mrss.bira3r1` is deprecated, use `cosa.bira3r1`
- `mrss.bira2c1` is deprecated, use `cosa.bira2c1`
- `mrss.bira2f1` is deprecated, use `cosa.bira2f1`
- `mrss.bira2r1` is deprecated, use `cosa.bira2r1`
- `mrss.to.mdes` is defunct, use `cosa.to.mdes`
- `mrss.to.power` is defunct, use `cosa.to.power`
- `optimal.ira1r1` is deprecated, use `cosa.ira1r1`
- `optimal.cra2r2` is deprecated, use `cosa.cra2r2`
- `optimal.cra3r3` is deprecated, use `cosa.cra3r3`

- optimal.cra4r4 is deprecated, use cosa.cra4r4
- optimal.bcra3f2 is deprecated, use cosa.bcra3f2
- optimal.bcra3r2 is deprecated, use cosa.bcra3r2
- optimal.bcra4r2 is deprecated, use cosa.bcra4r2
- optimal.bcra4f3 is deprecated, use cosa.bcra4f3
- optimal.bcra4r2 is deprecated, use cosa.bcra4r2
- optimal.bira4r1 is deprecated, use cosa.bira4r1
- optimal.bira3r1 is deprecated, use cosa.bira3r1
- optimal.bira2c1 is deprecated, use cosa.bira2c1
- optimal.bira2f1 is deprecated, use cosa.bira2f1
- optimal.bira2r1 is deprecated, use cosa.bira2r1
- optimal.to.mdes is deprecated, use cosa.to.mdes
- optimal.to.power is deprecated, use cosa.to.power
- plot.pars is defunct, there is no replacement function
- t1t2.error is defunct, there is no replacement function

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