

# Package ‘rddtools’

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**Title** Toolbox for Regression Discontinuity Design (‘RDD’)

**Description** Set of functions for Regression Discontinuity Design (‘RDD’), for data visualisation, estimation and testing.

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**Imports** KernSmooth, ggplot2, rdd, sandwich, lmtest, Formula, locpol, methods, rdrobust, rmarkdown

**Depends** AER, np

**Suggests** stats4, car, knitr, testthat

**License** GPL (>= 2)

**URL** <https://qua.st/rddtools/>

**BugReports** <https://github.com/bquast/rddtools/issues>

**VignetteBuilder** knitr

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as.lm	<i>Convert a rdd object to lm</i>
-------	-----------------------------------

---

### Description

Convert a rdd object to lm

### Usage

```
as.lm(x)
```

### Arguments

x                    An object to convert to lm

### Value

An object of class lm

### See Also

[as.npreg](#) which converts rdd\_reg objects into npreg from package np.

## Examples

```
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
reg_para <- rdd_reg_lm(rdd_object=house_rdd)
reg_para_lm <- as.lm(reg_para)
reg_para_lm
plot(reg_para_lm, which=4)
```

---

as.npregbw

*Convert an rdd\_reg object to a npreg object*

---

## Description

Convert an rdd\_object to a non-parametric regression npreg from package np

## Usage

```
as.npregbw(x, ...)
```

```
as.npreg(x, ...)
```

## Arguments

x                    Object of class rdd\_reg created by [rdd\\_reg\\_np](#) or [rdd\\_reg\\_lm](#)  
...                   Further arguments passed to the [npregbw](#) or [npreg](#)

## Details

This function converts an rdd\_reg object into an npreg object from package np. Note that the output won't be the same, since npreg does not offer a triangular kernel, but a Gaussian or Epanechnikov one. Another reason why estimates might differ slightly is that npreg implements a multivariate kernel, while rdd\_reg proceeds as if the kernel was univariate. A simple solution to make the multivariate kernel similar to the univariate one is to set the bandwidth for x and Dx to a large number, so that they converge towards a constant, and one obtains back the univariate kernel.

## Value

An object of class npreg or npregbw

## See Also

[as.lm](#) which converts rdd\_reg objects into lm.

**Examples**

```
# Estimate usual rdd_reg:
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
reg_nonpara <- rdd_reg_np(rdd_object=house_rdd)

## Convert to npreg:
reg_nonpara_np <- as.npreg(reg_nonpara)
reg_nonpara_np
rdd_coef(reg_nonpara_np, allCo=TRUE, allInfo=TRUE)

## Compare with result obtained with a Gaussian kernel:
bw_lm <- dnorm(house_rdd$x, sd=rddtools:::getBW(reg_nonpara))
reg_nonpara_gaus <- rdd_reg_lm(rdd_object=house_rdd, w=bw_lm)
all.equal(rdd_coef(reg_nonpara_gaus), rdd_coef(reg_nonpara_np))
```

---

clusterInf

*Post-inference for clustered data*


---

**Description**

Correct standard-errors to account for clustered data, doing either a degrees of freedom correction or using a heteroskedasticity-cluster robust covariance matrix possibly on the range specified by bandwidth

**Usage**

```
clusterInf(object, clusterVar, vcov. = NULL, type = c("df-adj", "HC"), ...)
```

**Arguments**

object	Object of class lm, from which rdd_reg also inherits.
clusterVar	The variable containing the cluster attributions.
vcov.	Specific covariance function to pass to coeftest. See help of sandwich
type	The type of cluster correction to use: either the degrees of freedom, or a HC matrix.
...	Further arguments passed to coeftest

**Value**

The output of the coeftest function, which is itself of class coeftest

**References**

Wooldridge (2003) Cluster-sample methods in applied econometrics. *American Economic Review*, 93, p. 133-138

**See Also**

[vcovCluster](#), which implements the cluster-robust covariance matrix estimator used by `clusterInf`

**Examples**

```
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
reg_para <- rdd_reg_lm(rdd_object=house_rdd)

# here we just generate randomly a cluster variable:
nlet <- sort(c(outer(letters, letters, paste, sep='')))
clusRandom <- sample(nlet[1:60], size=nrow(house_rdd), replace=TRUE)

# now do post-inference:
clusterInf(reg_para, clusterVar=clusRandom)
clusterInf(reg_para, clusterVar=clusRandom, type='HC')
```

---

 covarTest\_dis

*Testing for balanced covariates: equality of distribution*


---

**Description**

Tests equality of distribution with a Kolmogorov-Smirnov for each covariates, between the two full groups or around the discontinuity threshold

**Usage**

```
covarTest_dis(
  object,
  bw,
  exact = NULL,
  p.adjust = c("none", "holm", "BH", "BY", "hochberg", "hommel", "bonferroni")
)

## S3 method for class 'rdd_data'
covarTest_dis(
  object,
  bw = NULL,
  exact = FALSE,
  p.adjust = c("none", "holm", "BH", "BY", "hochberg", "hommel", "bonferroni")
)

## S3 method for class 'rdd_reg'
covarTest_dis(
  object,
  bw = NULL,
  exact = FALSE,
  p.adjust = c("none", "holm", "BH", "BY", "hochberg", "hommel", "bonferroni")
)
```

**Arguments**

object	object of class rdd_data
bw	a bandwidth
exact	Argument of the <a href="#">ks.test</a> function: NULL or a logical indicating whether an exact p-value should be computed.
p.adjust	Whether to adjust the p-values for multiple testing. Uses the <a href="#">p.adjust</a> function

**Value**

A data frame with, for each covariate, the K-S statistic and its p-value.

**Author(s)**

Matthieu Stigler <<Matthieu.Stigler@gmail.com>>

**See Also**

[covarTest\\_mean](#) for the t-test of equality of means

**Examples**

```
data(house)

## Add randomly generated covariates
set.seed(123)
n_Lee <- nrow(house)
Z <- data.frame(z1 = rnorm(n_Lee, sd=2),
               z2 = rnorm(n_Lee, mean = ifelse(house<0, 5, 8)),
               z3 = sample(letters, size = n_Lee, replace = TRUE))
house_rdd_Z <- rdd_data(y = house$y, x = house$x, covar = Z, cutpoint = 0)

## Kolmogorov-Smirnov test of equality in distribution:
covarTest_dis(house_rdd_Z, bw=0.3)

## Can also use function covarTest_dis() for a t-test for equality of means around cutoff:
covarTest_mean(house_rdd_Z, bw=0.3)
## covarTest_dis works also on regression outputs (bw will be taken from the model)
reg_nonpara <- rdd_reg_np(rdd_object=house_rdd_Z)
covarTest_dis(reg_nonpara)
```

---

covarTest\_mean

*Testing for balanced covariates: equality of means with t-test*

---

**Description**

Tests equality of means by a t-test for each covariate, between the two full groups or around the discontinuity threshold

**Usage**

```

covarTest_mean(
  object,
  bw = NULL,
  paired = FALSE,
  var.equal = FALSE,
  p.adjust = c("none", "holm", "BH", "BY", "hochberg", "hommel", "bonferroni")
)

## S3 method for class 'rdd_data'
covarTest_mean(
  object,
  bw = NULL,
  paired = FALSE,
  var.equal = FALSE,
  p.adjust = c("none", "holm", "BH", "BY", "hochberg", "hommel", "bonferroni")
)

## S3 method for class 'rdd_reg'
covarTest_mean(
  object,
  bw = NULL,
  paired = FALSE,
  var.equal = FALSE,
  p.adjust = c("none", "holm", "BH", "BY", "hochberg", "hommel", "bonferroni")
)

```

**Arguments**

object	object of class <code>rdd_data</code>
bw	a bandwidth
paired	Argument of the <code>t.test</code> function: logical indicating whether you want paired t-tests.
var.equal	Argument of the <code>t.test</code> function: logical variable indicating whether to treat the two variances as being equal
p.adjust	Whether to adjust the p-values for multiple testing. Uses the <code>p.adjust</code> function

**Value**

A data frame with, for each covariate, the mean on each size, the difference, t-stat and ts p-value.

**Author(s)**

Matthieu Stigler <<Matthieu.Stigler@gmail.com>>

**See Also**

[covarTest\\_dis](#) for the Kolmogorov-Smirnov test of equality of distribution

**Examples**

```

data(house)

## Add randomly generated covariates
set.seed(123)
n_Lee <- nrow(house)
Z <- data.frame(z1 = rnorm(n_Lee, sd=2),
               z2 = rnorm(n_Lee, mean = ifelse(house<0, 5, 8)),
               z3 = sample(letters, size = n_Lee, replace = TRUE))
house_rdd_Z <- rdd_data(y = house$y, x = house$x, covar = Z, cutpoint = 0)

## test for equality of means around cutoff:
covarTest_mean(house_rdd_Z, bw=0.3)

## Can also use function covarTest_dis() for Kolmogorov-Smirnov test:
covarTest_dis(house_rdd_Z, bw=0.3)

## covarTest_mean works also on regression outputs (bw will be taken from the model)
reg_nonpara <- rdd_reg_np(rdd_object=house_rdd_Z)
covarTest_mean(reg_nonpara)

```

dens\_test

*Run the McCrary test for manipulation of the forcing variable***Description**

Calls the [DCdensity](#) test from package `rdd` on a `rdd_object`.

**Usage**

```
dens_test(rdd_object, bin = NULL, bw = NULL, plot = TRUE, ...)
```

**Arguments**

<code>rdd_object</code>	object of class <code>rdd_data</code>
<code>bin</code>	Argument of the <a href="#">DCdensity</a> function, the binwidth
<code>bw</code>	Argument of the <a href="#">DCdensity</a> function, the bandwidth
<code>plot</code>	Whether to return a plot. Logical, default of TRUE.
<code>...</code>	Further arguments passed to <a href="#">DCdensity</a> .

**Examples**

```

data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
dens_test(house_rdd)

```



gen\_mc\_ik

*Generate Monte Carlo simulations of Imbens and Kalyanaraman***Description**

Generate the simulations reported in Imbens and Kalyanaraman (2012)

**Usage**

```
gen_mc_ik(
  n = 200,
  version = 1,
  sd = 0.1295,
  output = c("data.frame", "rdd_data"),
  size
)
```

**Arguments**

n	The size of sampel to generate
version	The MC version of Imbens and Kalnayaraman (between 1 and 4).
sd	The standard deviation of the error term.
output	Whether to return a data-frame, or already a rdd_data
size	The size of the effect, this depends on the specific version, defaults are as in ik: 0.04, NULL, 0.1, 0.1

**Value**

An data frame with x and y variables.

**Examples**

```
mc1_dat <- gen_mc_ik()
MC1_rdd <- rdd_data(y=mc1_dat$y, x=mc1_dat$x, cutpoint=0)

## Use np regression:
reg_nonpara <- rdd_reg_np(rdd_object=MC1_rdd)
reg_nonpara

# Represent the curves:
plotCu <- function(version=1, xlim=c(-0.1,0.1)){
  res <- gen_mc_ik(sd=0.000001, n=1000, version=version)
  res <- res[order(res$x),]
  ylim <- range(subset(res, x>=min(xlim) & x<=max(xlim), 'y'))
  plot(res, type='l', xlim=xlim, ylim=ylim, main=paste('DGP', version))
  abline(v=0)
  xCut <- res[which(res$x==min(res$x[res$x>=0]))+c(0,-1),]
```

```
  points(xCut, col=2)
}
layout(matrix(1:4,2, byrow=TRUE))
plotCu(version=1)
plotCu(version=2)
plotCu(version=3)
plotCu(version=4)
layout(matrix(1))
```

---

house

*Dataset used in Lee (2008)*

---

### Description

Randomized experiments from non-random selection in U.S. House elections

Dataset described used in Imbens and Kalyamaraman (2012), and probably the same dataset used in Lee (2008),

### Format

A data frame with 6558 observations and two variables:

**x** Vote at election t-1

**y** Vote at election t

### Source

Guido Imbens webpage: [https://scholar.harvard.edu/imbens/scholar\\_software/regression-discontinuity](https://scholar.harvard.edu/imbens/scholar_software/regression-discontinuity)

### References

Imbens, Guido and Karthik Kalyanaraman. (2012) 'Optimal Bandwidth Choice for the regression discontinuity estimator,' *Review of Economic Studies* (2012) 79, 933-959

Lee, D. (2008) Randomized experiments from non-random selection in U.S. House elections, *Journal of Econometrics*, 142, 675-697

### Examples

```
data(house)
rdd_house <- rdd_data(x=x, y=y, data=house, cutpoint=0)
summary(rdd_house)
plot(rdd_house)
```

---

`indh`*INDH data set*

---

**Description**

Data from the Initiative Nationale du Development Humaine, collected as the part of the SNSF project "Development Aid and Social Dynamics"

**Format**

A data frame with two variables with 720 observations each

**Source**

Development Aid and social Dyanmics website: <https://qua.st/Development-Aid-Social-Dynamics/>

**References**

Arcand, Rieger, and Nguyen (2015) 'Development Aid and Social Dyanmics Data Set'

**Examples**

```
# load the data
data(indh)

# construct rdd_data frame
rdd_dat_indh <- rdd_data(y=choice_pg, x=poverty, data=indh, cutpoint=30)

# inspect data frame
summary(rdd_dat_indh)

# perform non-parametric regression
( reg_np_indh <- rdd_reg_np(rdd_dat_indh) )
```

---

`plot.rdd_data`*Plot rdd\_data*

---

**Description**

Binned plot of the forcing and outcome variable

**Usage**

```
## S3 method for class 'rdd_data'
plot(
  x,
  h = NULL,
  nbins = NULL,
  xlim = range(object$x, na.rm = TRUE),
  cex = 0.7,
  nplot = 1,
  device = c("base", "ggplot"),
  ...
)
```

**Arguments**

x	Object of class rdd_data
h	The binwidth parameter (note this differs from the bandwidth parameter!)
nbins	Alternative to h, the total number of bins in the plot.
xlim	The range of the x data
cex	Size of the points, see <a href="#">par</a>
nplot	Number of plot to draw
device	Type of device used. Currently not used.
...	Further arguments passed to the <a href="#">plot</a> function.

**Details**

Produces a simple binned plot averaging values within each interval. The length of the intervals is specified with the argument h, specifying the whole binwidth (contrary to the usual bandwidth argument, that gives half of the length of the kernel window. When no bandwidth is given, the bandwidth of Ruppert et al is used, see [rdd\\_bw\\_rsw](#).

**Value**

A plot

**Author(s)**

Matthieu Stigler <<Matthieu.Stigler@gmail.com>>

**Examples**

```
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
plot(house_rdd)

## Specify manually the bandwidth:
plot(house_rdd, h=0.2)
```

```
## Show three plots with different bandwidth:
plot(house_rdd, h=c(0.2,0.3,0.4), nplot=3)

## Specify instead of the bandwidth, the final number of bins:
plot(house_rdd, nbins=22)

## If the specified number of bins is odd, the larger number is given to side with largest range
plot(house_rdd, nbins=21)
```

---

plotBin

*Bin plotting*


---

### Description

Do a 'scatterplot bin smoothing'

### Usage

```
plotBin(
  x,
  y,
  h = NULL,
  nbins = NULL,
  cutpoint = 0,
  plot = TRUE,
  type = c("value", "number"),
  xlim = range(x, na.rm = TRUE),
  cex = 0.9,
  main = NULL,
  xlab,
  ylab,
  ...
)
```

### Arguments

x	Forcing variable
y	Output
h	the bandwidth (defaults to $2 * \text{sd}(\text{runvar}) * \text{length}(\text{runvar})^{-.5}$ )
nbins	number of Bins
cutpoint	Cutpoint
plot	Logical. Whether to plot or only returned silently
type	Whether returns the y averages, or the x frequencies
xlim, cex, main, xlab, ylab	Usual parameters passed to plot(), see <a href="#">par</a>
...	further arguments passed to plot.

**Value**

Returns silently values

**References**

McCrary, Justin.

---

plotPlacebo	<i>Draw a (density) plot of placebo tests</i>
-------------	---

---

**Description**

Draw a plot of placebo tests, estimating the impact on fake cutpoints

**Usage**

```
plotPlacebo(object, device = c("ggplot", "base"), ...)

## S3 method for class 'rdd_reg'
plotPlacebo(
  object,
  device = c("ggplot", "base"),
  from = 0.25,
  to = 0.75,
  by = 0.1,
  level = 0.95,
  same_bw = FALSE,
  vcov. = NULL,
  plot = TRUE,
  output = c("data", "ggplot"),
  ...
)

plotPlaceboDens(object, device = c("ggplot", "base"), ...)

## S3 method for class 'rdd_reg'
plotPlaceboDens(
  object,
  device = c("ggplot", "base"),
  from = 0.25,
  to = 0.75,
  by = 0.1,
  level = 0.95,
  same_bw = FALSE,
  vcov. = NULL,
  ...
)
```

```
computePlacebo(
  object,
  from = 0.25,
  to = 0.75,
  by = 0.1,
  level = 0.95,
  same_bw = FALSE,
  vcov. = NULL
)
```

### Arguments

object	the output of an RDD regression
device	Whether to draw a base or a ggplot graph.
from	Starting point of the fake cutpoints sequence. Refers to the quantile of each side of the true cutpoint
to	Ending point of the fake cutpoints sequence. Refers to the quantile of each side of the true cutpoint
by	Increments of the from-to sequence
level	Level of the confidence interval shown
same_bw	Whether to re-estimate the bandwidth at each point
vcov.	Specific covariance function to pass to <code>coefest</code> . See help of package <a href="#">sandwich</a> .
plot	Whether to actually plot the data.
output	Whether to return (invisibly) the data frame containing the bandwidths and corresponding estimates, or the ggplot object
...	Further arguments passed to specific methods.

### Value

A data frame containing the cutpoints, their corresponding estimates and confidence intervals.

### Author(s)

Matthieu Stigler <<Matthieu.Stigler@gmail.com>>

### Examples

```
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
reg_nonpara <- rdd_reg_np(rdd_object=house_rdd)
plotPlacebo(reg_nonpara)

# Use with another vcov function; cluster case
reg_nonpara_lminf <- rdd_reg_np(rdd_object=house_rdd, inference='lm')
# need to be a function applied to updated object!
vc <- function(x) vcovCluster(x, clusterVar=model.frame(x)$x)
plotPlacebo(reg_nonpara_lminf, vcov. = vc)
```

---

`plotSensi`*Plot the sensitivity to the bandwidth*

---

**Description**

Draw a plot showing the LATE estimates depending on multiple bandwidths

**Usage**

```
plotSensi(  
  rdd_regobject,  
  from,  
  to,  
  by = 0.01,  
  level = 0.95,  
  output = c("data", "ggplot"),  
  plot = TRUE,  
  ...  
)  
  
## S3 method for class 'rdd_reg_np'  
plotSensi(  
  rdd_regobject,  
  from,  
  to,  
  by = 0.05,  
  level = 0.95,  
  output = c("data", "ggplot"),  
  plot = TRUE,  
  device = c("ggplot", "base"),  
  vcov. = NULL,  
  ...  
)  
  
## S3 method for class 'rdd_reg_lm'  
plotSensi(  
  rdd_regobject,  
  from,  
  to,  
  by = 0.05,  
  level = 0.95,  
  output = c("data", "ggplot"),  
  plot = TRUE,  
  order,  
  type = c("colour", "facet"),  
  ...  
)
```



**Arguments**

rdd_regobject	object of a RDD regression, from either <a href="#">rdd_reg_lm</a> or <a href="#">rdd_reg_np</a>
from	First bandwidth point. Default value is $\max(1e-3, bw-0.1)$
to	Last bandwidth point. Default value is $bw+0.1$
by	Increments in the from to sequence
level	Level of the confidence interval
output	Whether to return (invisibly) the data frame containing the bandwidths and corresponding estimates, or the ggplot object
plot	Whether to actually plot the data.
device	Whether to draw a base or a ggplot graph.
vcov.	Specific covariance function to pass to <code>coefest</code> . See help of package <a href="#">sandwich</a>
order	For parametric models (from <a href="#">rdd_reg_lm</a> ), the order of the polynomial.
type	For parametric models (from <a href="#">rdd_reg_lm</a> ) whether different orders are represented as different colour or as different facets.
...	Further arguments passed to specific methods

**Value**

A data frame containing the bandwidths and corresponding estimates and confidence intervals.

**Author(s)**

Matthieu Stigler <<Matthieu.Stigler@gmail.com>>

**Examples**

```
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)

#Non-parametric estimate
bw_ik <- rdd_bw_ik(house_rdd)
reg_nonpara <- rdd_reg_np(rdd_object=house_rdd, bw=bw_ik)
plotSensi(reg_nonpara)
plotSensi(reg_nonpara, device='base')

#Parametric estimate:
reg_para_ik <- rdd_reg_lm(rdd_object=house_rdd, order=4, bw=bw_ik)
plotSensi(reg_para_ik)
plotSensi(reg_para_ik, type='facet')
```

**Description**

Set of functions for Regression Discontinuity Design ('RDD'), for data visualisation, estimation and testing.

---

rdd_bw_cct_estim	<i>Bandwidth selection for Regression Discontinuity estimators, CTT 2014</i>
------------------	--

---

### Description

Simple wrapper of the Calonico-Cattaneo-Titiunik (2014) bandwidth selection procedures for RDD estimators [rdbwselect](#).

### Usage

```
rdd_bw_cct_estim(
  rdd_object,
  method = c("mserd", "msetwo", "msexsum", "msecomb1", "msecomb2", "cerrd", "certwo",
             "cersum", "cercomb1"),
  kernel = c("Triangular", "Uniform", "Epanechnikov"),
  ...
)
```

### Arguments

rdd_object	of class rdd_data created by <a href="#">rdd_data</a>
method	The type of method used. See
kernel	The type of kernel used: either Triangular, Uniform or Epanechnikov.
...	further arguments passed to <a href="#">rdbwselect</a> .

### Value

See documentation of [rdbwselect](#)

### Author(s)

Original code written by Calonico, Cattaneo, Farrell and Titiuni, see [rdbwselect](#)

### References

Calonico, S., M. D. Cattaneo, and R. Titiunik. 2014a. Robust Nonparametric Confidence Intervals for Regression-Discontinuity Designs. *Econometrica* 82(6): 2295-2326. <https://www.tandfonline.com/doi/abs/10.1080/01621459.2015.1017578>.

### See Also

[rdd\\_bw\\_ik](#) Local RDD bandwidth selector using the plug-in method of Imbens and Kalyanaraman (2012)

**Examples**

```
data(house)
rd<- rdd_data(x=house$x, y=house$y, cutpoint=0)
rdd_bw_cct_estim(rd)
```

---

rdd_bw_cct_plot	<i>Bandwidth selection for Regression Discontinuity visualisation, CTT 2015</i>
-----------------	---

---

**Description**

Simple wrapper of the Calonico-Cattaneo-Titiunik (2015) bandwidth selection procedures for RDD visualisation [rdplot](#).

**Usage**

```
rdd_bw_cct_plot(
  rdd_object,
  method = c("esmv", "es", "espr", "esmvpr", "qs", "qspr", "qsmv", "qsmvpr"),
  ...
)
```

**Arguments**

rdd_object	of class rdd_data created by <a href="#">rdd_data</a>
method	The type of method used. See <a href="#">rdplot</a> . Default is esmv, the variance mimicking evenly-spaced method.
...	further arguments passed to <a href="#">rdplot</a> .

**Value**

See documentation of [rdplot](#)

**Author(s)**

Original code written by Calonico, Cattaneo, Farrell and Titiuni, see [rdplot](#)

**References**

Calonico, S., M. D. Cattaneo, and R. Titiunik. 2015a. Optimal Data-Driven Regression Discontinuity Plots. *Journal of the American Statistical Association* 110(512): 1753-1769. <https://www.tandfonline.com/doi/abs/10.1080/01621459.2015.1017578>.

**See Also**

[rdd\\_bw\\_ik](#) Local RDD bandwidth selector using the plug-in method of Imbens and Kalyanaraman (2012)

### Examples

```
data(house)
rd<- rdd_data(x=house$x, y=house$y, cutpoint=0)
rdd_bw_cct_plot(rd)
```

---

rdd\_bw\_ik

*Imbens-Kalyanaraman Optimal Bandwidth Calculation*

---

### Description

Imbens-Kalyanaraman optimal bandwidth for local linear regression in Regression discontinuity designs.

### Usage

```
rdd_bw_ik(rdd_object, kernel = c("Triangular", "Uniform", "Normal"))
```

### Arguments

rdd\_object      of class rdd\_data created by [rdd\\_data](#)  
kernel            The type of kernel used: either triangular or uniform.

### Value

The optimal bandwidth

### Author(s)

Matthieu Stigler <<Matthieu.Stigler@gmail.com>>

### References

Imbens, Guido and Karthik Kalyanaraman. (2012) 'Optimal Bandwidth Choice for the regression discontinuity estimator,' *Review of Economic Studies* (2012) 79, 933-959

### See Also

[rdd\\_bw\\_rsw](#) Global bandwidth selector of Ruppert, Sheather and Wand (1995)

### Examples

```
data(house)
rd<- rdd_data(x=house$x, y=house$y, cutpoint=0)
rdd_bw_ik(rd)
```

---

rdd_bw_rsw	<i>Global bandwidth selector of Ruppert, Sheather and Wand (1995)</i> from package <b>KernSmooth</b>
------------	---

---

### Description

Uses the global bandwidth selector of Ruppert, Sheather and Wand (1995) either to the whole function, or to the functions below and above the cutpoint.

### Usage

```
rdd_bw_rsw(object, type = c("global", "sided"))
```

### Arguments

object	object of class <code>rdd_data</code> created by <a href="#">rdd_data</a>
type	Whether to choose a global bandwidth for the whole function ( <code>global</code> ) or for each side ( <code>sided</code> )

### Value

One (or two for `sided`) bandwidth value.

### References

See [dpill](#)

### See Also

[rdd\\_bw\\_ik](#) Local RDD bandwidth selector using the plug-in method of Imbens and Kalyanaraman (2012)

### Examples

```
data(house)
rd<- rdd_data(x=house$x, y=house$y, cutpoint=0)
rdd_bw_rsw(rd)
```

---

rdd_coef	<i>RDD coefficient</i>
----------	------------------------

---

### Description

Function to access the RDD coefficient in the various regressions

### Usage

```
rdd_coef(object, allInfo = FALSE, allCo = FALSE, ...)

## Default S3 method:
rdd_coef(object, allInfo = FALSE, allCo = FALSE, ...)

## S3 method for class 'rdd_reg_np'
rdd_coef(object, allInfo = FALSE, allCo = FALSE, ...)
```

### Arguments

object	A RDD regression object
allInfo	whether to return just the coefficients (allInfo=FALSE) or also the se/t stat/pval.
allCo	Whether to give only the RDD coefficient (allCo=FALSE) or all coefficients
...	Further arguments passed to/from specific methods

### Value

Either a numeric value of the RDD coefficient estimate, or a data frame with the estimate, its standard value, t test and p-value and

---

rdd_data	<i>Construct rdd_data</i>
----------	---------------------------

---

### Description

Construct the base RDD object, containing x, y and the cutpoint, eventually covariates.

### Usage

```
rdd_data(y, x, covar, cutpoint, z, labels, data)
```

**Arguments**

y	Output
x	Forcing variable
covar	Exogeneous variables
cutpoint	Cutpoint
z	Assignment variable for the fuzzy case. Should be 0/1 or TRUE/FALSE variable.
labels	Additional labels to provide as list (with entries x, y, and eventually vector covar). Unused currently.
data	A data-frame for the x and y variables. If this is provided, the column names can be entered directly for argument x and y

**Value**

Object of class `rdd_data`, inheriting from `data.frame`

**Author(s)**

Matthieu Stigler <<Matthieu.Stigler@gmail.com>>

**Examples**

```
data(house)
rd<- rdd_data(x=house$x, y=house$y, cutpoint=0)
rd2 <- rdd_data(x=x, y=y, data=house, cutpoint=0)

# The print() function is the same as the print.data.frame:
rd

# The summary() and plot() function are specific to rdd_data
summary(rd)
plot(rd)

# for the fuzzy case, you need to specify the assignment variable z:
rd_dat_fakefuzzy <- rdd_data(x=house$x, y=house$y,
                           z=ifelse(house$x>0+rnorm(nrow(house), sd=0.05),1,0),
                           cutpoint=0)
summary(rd_dat_fakefuzzy)
```

---

rdd\_gen\_reg

*General polynomial estimator of the regression discontinuity*


---

**Description**

Compute RDD estimate allowing a locally kernel weighted version of any estimation function possibly on the range specified by bandwidth

**Usage**

```
rdd_gen_reg(
  rdd_object,
  fun = glm,
  covariates = NULL,
  order = 1,
  bw = NULL,
  slope = c("separate", "same"),
  covar.opt = list(strategy = c("include", "residual"), slope = c("same", "separate"),
    bw = NULL),
  weights,
  ...
)
```

**Arguments**

rdd_object	Object of class rdd_data created by <a href="#">rdd_data</a>
fun	The function to estimate the parameters
covariates	Formula to include covariates
order	Order of the polynomial regression.
bw	A bandwidth to specify the subset on which the kernel weighted regression is estimated
slope	Whether slopes should be different on left or right (separate), or the same.
covar.opt	Options for the inclusion of covariates. Way to include covariates, either in the main regression (include) or as regressors of y in a first step (residual).
weights	Optional weights to pass to the lm function. Note this cannot be entered together with bw
...	Further arguments passed to fun. See the example.

**Details**

This function allows the user to use a custom estimating function, instead of the traditional `lm()`. It is assumed that the custom function has following behaviour:

1. A formula interface, together with a data argument
2. A weight argument
3. A `coef(summary(x))` returning a data-frame containing a column Estimate

Note that for the last requirement, this can be accommodated by writing a specific [rdd\\_coef](#) function for the class of the object returned by fun.

**Value**

An object of class `rdd_reg_lm` and class `lm`, with specific print and plot methods



**References**

TODO

**Examples**

```
## Step 0: prepare data
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)

## Estimate a local probit:
house_rdd$y <- with(house_rdd, ifelse(y<quantile(y, 0.25), 0,1))
reg_bin_glm <- rdd_gen_reg(rdd_object=house_rdd, fun= glm, family=binomial(link='probit'))
print(reg_bin_glm)
summary(reg_bin_glm)
```

---

rdd\_pred

*RDD coefficient prediction*


---

**Description**

Function to predict the RDD coefficient in presence of covariate (without covariates, returns the same than [rdd\\_coef](#))

**Usage**

```
rdd_pred(
  object,
  covdata,
  se.fit = TRUE,
  vcov. = NULL,
  newdata,
  stat = c("identity", "sum", "mean"),
  weights
)
```

**Arguments**

object	A RDD regression object
covdata	New data.frame specifying the values of the covariates, can have multiple rows.
se.fit	A switch indicating if standard errors are required.
vcov.	Specific covariance function (see package <code>sandwich</code> ), by default uses the <code>vcov</code>
newdata	Another data on which to evaluate the x/D variables. Useful in very few cases.
stat	The statistic to use if there are multiple predictions, 'identity' just returns the single values, 'mean' averages them
weights	Eventual weights for the averaging of the predicted values.

## Details

The function `rdd_pred` does a simple prediction of the RDD effect

$$RDDeffect = \mu(x, z, D = 1) - \mu(x, z, D = 0)$$

When there are no covariates (and  $z$  is irrelevant in the equation above), this amounts exactly to the usual RDD coefficient, shown in the outputs, or obtained with `rdd_coef`. If there were covariates, and if these covariates were estimated using the “include” *strategy* and with different coefficients left and right to the cutoff (i.e. had argument `slope = “separate”`), then the RDD effect is also dependent on the value of the covariate(s). `rdd_pred` allows to set the value of the covariate(s) at which to evaluate the RDD effect, by providing a `data.frame` with the values for the covariates. Note that the effect can be evaluated at multiple points, if you provide multiple rows of `covdata`.

In presence of covariate-specific RDD effect, one may wish to estimate an average effect. This can be done by setting the argument `stat='mean'`. Weights can additionally be added, with the argument `weights`, to obtain a weighted-average of the predictions. Note however that in most cases, this will be equivalent to provide covariates at their (weighted) mean value, which will be much faster also!

Standard errors, obtained setting the argument `se.fit=TRUE`, are computed using following formula:

$$x_i \Omega x_i'$$

where  $\Omega$  is the estimated variance-covariance matrix ( by default  $\sigma^2(X'X)^{-1}$  using `vcov`) and  $x_i$  is the input data (a mix of `covdata` and input data). If one wishes individual predictions, standard errors are simply obtained as the square of that diagonal matrix, whereas for mean/sum, covariances are taken into account.

## Value

Returns the predicted value(s), and, if `se.fit=TRUE`, their standard errors.

## References

Froehlich (2007) Regression discontinuity design with covariates, IZA discussion paper 3024

## Examples

```
# Load data, add (artificial) covariates:
data(house)
n_Lee <- nrow(house)
z1 <- runif(n_Lee)
house_rdd <- rdd_data(y=y, x=x, data=house, covar=z1, cutpoint=0)

# estimation without covariates: rdd_pred is the same than rdd_coef:
reg_para <- rdd_reg_lm(rdd_object=house_rdd)

rdd_pred(reg_para)
rdd_coef(reg_para, allInfo=TRUE)

# estimation with covariates:
reg_para_cov <- rdd_reg_lm(rdd_object=house_rdd,
```

```

covariates='z1',
covar.opt=list(slope='separate') )

# should obtain same result as with RDestimate
rdd_pred(reg_para_cov, covdata=data.frame(z1=0))

# evaluate at mean of z1 (as comes from uniform)
rdd_pred(reg_para_cov, covdata=data.frame(z1=0.5))

```

rdd\_reg\_lm

*Parametric polynomial estimator of the regression discontinuity***Description**

Compute a parametric polynomial regression of the ATE, possibly on the range specified by bandwidth

**Usage**

```

rdd_reg_lm(
  rdd_object,
  covariates = NULL,
  order = 1,
  bw = NULL,
  slope = c("separate", "same"),
  covar.opt = list(strategy = c("include", "residual"), slope = c("same", "separate"),
    bw = NULL),
  covar.strat = c("include", "residual"),
  weights
)

```

**Arguments**

rdd_object	Object of class rdd_data created by <a href="#">rdd_data</a>
covariates	Formula to include covariates
order	Order of the polynomial regression.
bw	A bandwidth to specify the subset on which the parametric regression is estimated
slope	Whether slopes should be different on left or right (separate), or the same.
covar.opt	Options for the inclusion of covariates. Way to include covariates, either in the main regression (include) or as regressors of y in a first step (residual).
covar.strat	DEPRECATED, use covar.opt instead.
weights	Optional weights to pass to the lm function. Note this cannot be entered together with bw

## Details

This function estimates the standard *discontinuity regression*:

$$Y = \alpha + \tau D + \beta_1(X - c) + \beta_2 D(X - c) + \epsilon$$

with  $\tau$  the main parameter of interest. Several versions of the regression can be estimated, either restricting the slopes to be the same, i.e.  $\beta_1 = \beta_2$  (argument `slope`). The order of the polynomial in  $X - c$  can also be adjusted with argument `order`. Note that a value of zero can be used, which corresponds to the simple *difference in means*, that one would use if the samples were random. Covariates can also be added in the regression, according to the two strategies discussed in Lee and Lemieux (2010, sec 4.5), through argument `covar.strat`:

**include** Covariates are simply added as supplementary regressors in the RD equation

**residual** The dependent variable is first regressed on the covariates only, then the RDD equation is applied on the residuals from this first step

The regression can also be estimated in a neighborhood of the cutpoint with the argument `bw`. This make the parametric regression resemble the non-parametric local kernel `rdd_reg_np`. Similarly, weights can also be provided (but not simultaneously to `bw`).

The returned object is a classical `lm` object, augmented with a `RDDs1ot`, so usual methods can be applied. As is done in general in R, heteroskedasticity-robust inference can be done later on with the usual function from package **sandwich**. For the case of clustered observations a specific function `clusterInf` is provided.

## Value

An object of class `rdd_reg_lm` and class `lm`, with specific print and plot methods

## Examples

```
## Step 0: prepare data
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
## Step 2: regression
# Simple polynomial of order 1:
reg_para <- rdd_reg_lm(rdd_object=house_rdd)
print(reg_para)
plot(reg_para)

# Simple polynomial of order 4:
reg_para4 <- rdd_reg_lm(rdd_object=house_rdd, order=4)
reg_para4
plot(reg_para4)

# Restrict sample to bandwidth area:
bw_ik <- rdd_bw_ik(house_rdd)
reg_para_ik <- rdd_reg_lm(rdd_object=house_rdd, bw=bw_ik, order=4)
reg_para_ik
plot(reg_para_ik)
```

---

rdd\_reg\_np

*Parametric polynomial estimator of the regression discontinuity*


---

### Description

Compute a parametric polynomial regression of the ATE, possibly on the range specified by bandwidth

### Usage

```
rdd_reg_np(
  rdd_object,
  covariates = NULL,
  bw = rdd_bw_ik(rdd_object),
  slope = c("separate", "same"),
  inference = c("np", "lm"),
  covar.opt = list(slope = c("same", "separate"), bw = NULL)
)
```

### Arguments

rdd_object	Object of class rdd_data created by <a href="#">rdd_data</a>
covariates	TODO
bw	A bandwidth to specify the subset on which the parametric regression is estimated
slope	Whether slopes should be different on left or right (separate), or the same.
inference	Type of inference to conduct: non-parametric one (np) or standard (lm). See details.
covar.opt	Options for the inclusion of covariates. Way to include covariates, either in the main regression (include) or as regressors of y in a first step (residual).

### Value

An object of class rdd\_reg\_np and class lm, with specific print and plot methods

### References

TODO

### See Also

[rdd\\_bw\\_ik](#) Bandwidth selection using the plug-in bandwidth of Imbens and Kalyanaraman (2012)

**Examples**

```
## Step 0: prepare data
data(house)
house_rdd <- rdd_data(y=house$y, x=house$x, cutpoint=0)
## Step 2: regression
# Simple polynomial of order 1:
reg_nonpara <- rdd_reg_np(rdd_object=house_rdd)
print(reg_nonpara)
plot(reg_nonpara)
```

---

rot\_bw

*Bandwidth selector*


---

**Description**

implements dpill

**Usage**

```
rot_bw(object)
```

**Arguments**

object            object of class rdd\_data

**References**

McCrary, Justin. (2008) 'Manipulation of the running variable in the regression discontinuity design: A density test,' *Journal of Econometrics*. 142(2): 698-714.

**Examples**

```
#No discontinuity
```

---

STAR\_MHE

*Transformation of the STAR dataset as used in Angrist and Pischke (2008)*


---

**Description**

Transformation of the STAR dataset as used in Table 8.2.1 of Angrist and Pischke (2008)

**Format**

A data frame containing 5743 observations and 6 variables. The first variable is from the original dataset, all other are created by Angrist and Pischke STAT code.

**schidkn** School ID in kindergarden (original variable, schoolidk in [STAR](#))

**pscore** The propensity score (computed by A & P)

**classid** The id of the class (computed by A & P)

**cs** Class size (computed by A & P)

**female, nwhite** Various covariates (computed by A & P)

**Details**

). This is a transformation of the dataset from the project STAR (Student/Teacher Achievement Ratio). The full dataset is described and available in package AER, [STAR](#). The transformed data was obtained using the STATA script `krueger.do`, obtained from Joshua Angrist website (<https://economics.mit.edu/faculty/angrist/data1/mhe/krueger>), on the `webstar.dta`.

**Source**

Data obtained using the script `krueger.do` on data `webstar.rda`, found on J. Angrist website <https://economics.mit.edu/faculty/angrist/data1/mhe/krueger>, retrieved on 26 November 2012.

**References**

Krueger, A. (1999) 'Experimental Estimates Of Education Production Functions,' *The Quarterly Journal of Economics*, Vol. 114(2), pages 497-532, May.

Angrist, A. ad Pischke J-S (2008) *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton University press

**See Also**

[STAR](#) for the original dataset.

**Examples**

```
data(STAR_MHE)

# Compute the group means:
STAR_MHE_means <- aggregate(STAR_MHE[, c('classid', 'pscore', 'cs')],
                             by=list(STAR_MHE$classid), mean)

# Regression of means, with weighted average:
reg_krug_gls <- lm(pscore~cs, data=STAR_MHE_means, weights=cs)
coef(summary(reg_krug_gls))[2,2]
```

---

vcovCluster	<i>Cluster Heteroskedasticity-consistent estimation of the covariance matrix.</i>
-------------	---

---

### Description

Offer a cluster variant of the usual Heteroskedasticity-consistent

### Usage

```
vcovCluster(object, clusterVar)
```

```
vcovCluster2(object, clusterVar1, clusterVar2)
```

### Arguments

object            Object of class `lm`, from which `rdd_reg` also inherits.

clusterVar        The variable containing the cluster attributions.

clusterVar1, clusterVar2  
                  The two cluster variables for the 2-cluster case.

### Value

A matrix containing the covariance matrix estimate.

### Author(s)

Mahmood Arai, see <http://people.su.se/~ma/econometrics.html>

### References

Cameron, C., Gelbach, J. and Miller, D. (2011) Robust Inference With Multiway Clustering, *Journal of Business and Economic Statistics*, vol. 29(2), pages 238-249. #<sup>1</sup> @references Wooldridge (2003) Cluster-sample methods in applied econometrics. *American Economic Review*, 93, p. 133-138

Arai, M. (2011) Cluster-robust standard errors using R, Note available <http://people.su.se/~ma/clustering.pdf>.

### See Also

`clusterInf` for a direct function, allowing also alternative cluster inference methods.



**Examples**

```

data(STAR_MHE)
if(all(c(require(sandwich), require(lmtest)))){

# Run simple regression:
reg_krug <- lm(pscore~cs, data=STAR_MHE)

# Row 1 of Table 8.2.1, inference with standard vcovHC:
coeftest(reg_krug,vcov.=vcovHC(reg_krug, 'HC1'))[2,2]

# Row 4 of Table 8.2.1, inference with cluster vcovHC:
coeftest(reg_krug,vcov.=vcovCluster(reg_krug, clusterVar=STAR_MHE$classid))[2,2]
}

```

---

waldci

*Confint allowing vcov*


---

**Description**

Version of vcov allowing for confint

**Usage**

```
waldci(x, parm = NULL, level = 0.95, vcov. = NULL, df = NULL, ...)
```

**Arguments**

x	Object of class lm or else
parm	specification of which parameters are to be given confidence intervals, see confint
level	the confidence level required, see confint()
vcov.	Specific covariance function to pass to coeftest. See help of sandwich
df	Degrees of freedom
...	Further arguments

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