

# Package ‘GD’

October 17, 2024

**Title** Geographical Detectors for Assessing Spatial Factors

**Version** 10.5

**Description** Geographical detectors for measuring spatial stratified heterogeneity, as described in Jinfeng Wang (2010) <[doi:10.1080/13658810802443457](https://doi.org/10.1080/13658810802443457)> and Jinfeng Wang (2016) <[doi:10.1016/j.ecolind.2016.02.052](https://doi.org/10.1016/j.ecolind.2016.02.052)>. Includes the optimal discretization of continuous data, four primary functions of geographical detectors, comparison of size effects of spatial unit and the visualizations of results. To use the package and to refer the descriptions of the package, methods and case datasets, please cite Yongze Song (2020) <[doi:10.1080/15481603.2020.1760434](https://doi.org/10.1080/15481603.2020.1760434)>. The model has been applied in factor exploration of road performance and multi-scale spatial segmentation for network data, as described in Yongze Song (2018) <[doi:10.3390/rs10111696](https://doi.org/10.3390/rs10111696)> and Yongze Song (2020) <[doi:10.1109/TITS.2020.3001193](https://doi.org/10.1109/TITS.2020.3001193)>, respectively.

**License** GPL-3

**Encoding** UTF-8

**RoxygenNote** 7.3.2

**URL** <https://github.com/ausgis/GD>, <https://ausgis.github.io/GD/>

**BugReports** <https://github.com/ausgis/GD/issues>

**Depends** R (>= 4.1.0)

**Imports** BAMMtools, graphics, stats, utils

**Suggests** knitr, rmarkdown

**LazyData** true

**VignetteBuilder** knitr

**NeedsCompilation** no

**Author** Yongze Song [aut, cph] (<<https://orcid.org/0000-0003-3420-9622>>),  
Wenbo Lv [aut, cre] (<<https://orcid.org/0009-0002-6003-3800>>)

**Maintainer** Wenbo Lv <[lyu.geosocial@gmail.com](mailto:lyu.geosocial@gmail.com)>

**Repository** CRAN

**Date/Publication** 2024-10-17 16:40:02 UTC

## Contents

disc	2
gd	3
gdeco	3
gdinteract	4
gdm	5
gdrisk	6
H1N1	7
NDVI	7
optidisc	8
riskmean	9
sesu	10
v2m	11
<b>Index</b>	<b>12</b>

---

disc	<i>Generates discretization parameters for continuous data.</i>
------	-----------------------------------------------------------------

---

### Description

Function for discretizing continuous data and obtaining the different outputs, including discretization intervals, numbers of values within intervals, and visualization of discretization.

### Usage

```
disc(var, n, method = "quantile", ManualItv)
```

### Arguments

var	A numeric vector of continuous variable
n	The number of intervals
method	A character of discretization method
ManualItv	A numeric vector of manual intervals

### Examples

```
## method is default (quantile); number of intervals is 4
ds1 <- disc(ndvi_40$Tempchange, 4)
ds1
## method is equal; number of intervals is 4
ds2 <- disc(ndvi_40$Tempchange, 4, method = "equal")
## method is manual; number of intervals is 4
manualitv1 <- c(-0.5, 0, 1, 2, 4)
ds3 <- disc(ndvi_40$Tempchange, 4, method = "manual", ManualItv = manualitv1)
```

---

gd *Geographical detectors: factor detector.*

---

### Description

Function for calculating power determinant using factor detector of geographical detectors and visualization.

### Usage

```
gd(formula, data = NULL)
## S3 method for class 'gd'
print(x, ...)
## S3 method for class 'gd'
plot(x, sig = TRUE, ...)
```

### Arguments

formula	A formula of response and explanatory variables
data	A data.frame includes response and explanatory variables
x	A list of factor detector results
sig	If TRUE, only spatial associations that are significant at the 0.05 level will be plotted; If FALSE, all spatial associations will be plotted.
...	Ignore

### Examples

```
g1 <- gd(NDVIchange ~ Climatezone + Mining, data = ndvi_40)
g1
plot(g1)
```

---

gdeco *Geographical detectors: ecological detector.*

---

### Description

Function for ecological detector calculation, ecological matrix and visualization.

### Usage

```
gdeco(formula, data = NULL)
## S3 method for class 'gdeco'
print(x, ...)
## S3 method for class 'gdeco'
plot(x, ...)
```

**Arguments**

formula	A formula of response and explanatory variables
data	A data.frame includes response and explanatory variables
x	A list of ecological detector results
...	Ignore

**Examples**

```
ge1 <- gdeco(NDVIchange ~ Climatezone + Mining, data = ndvi_40)
ge1

data <- ndvi_40[,1:3]
ge2 <- gdeco(NDVIchange ~ ., data = data)
ge2
```

---

gdinteract

*Geographical detectors: interaction detector.*


---

**Description**

Function for interaction detector calculation and visualization. The types of interactions include "Enhance, nonlinear", "Independent", "Enhance, bi-", "Weaken, uni-" and "Weaken, nonlinear".

**Usage**

```
gdinteract(formula, data = NULL)
## S3 method for class 'gdinteract'
print(x, ...)
## S3 method for class 'gdinteract'
plot(x, ...)
```

**Arguments**

formula	A formula of response and explanatory variables
data	A data.frame includes response and explanatory variables
x	A list of interaction detector results
...	Ignore

**Examples**

```

gi1 <- gdinteract(NDVIchange ~ Climatezone + Mining, data = ndvi_40)
gi1

data <- ndvi_40[,1:3]
gi2 <- gdinteract(NDVIchange ~ ., data = data)
gi2

```

gdm

*Geographical detectors: a one-step function.***Description**

A one-step function for optimal discretization and geographical detectors for multiple variables and visualization.

**Usage**

```

gdm(formula, continuous_variable = NULL, data = NULL, discmethod, discitv)
## S3 method for class 'gdm'
print(x, ...)
## S3 method for class 'gdm'
plot(x, ...)

```

**Arguments**

formula	A formula of response and explanatory variables
continuous_variable	A vector of continuous variable names
data	A data.frame includes response and explanatory variables
discmethod	A character vector of discretization methods
discitv	A numeric vector of numbers of intervals
x	A list of gdm result
...	Ignore

**Examples**

```

#####
## NDVI: ndvi_40
#####
## set optional parameters of optimal discretization
## optional methods: equal, natural, quantile, geometric, sd and manual
discmethod <- c("equal","quantile")
discitv <- c(4:5)

```

```

## "gdm" function
ndvigdm <- gdm(NDVIchange ~ Climatezone + Mining + Tempchange,
              continuous_variable = c("Tempchange"),
              data = ndvi_40,
              discmethod = discmethod, discitv = discitv)

ndvigdm
plot(ndvigdm)
## Not run:
#####
## H1N1: h1n1_100
#####
## set optional parameters of optimal discretization
discmethod <- c("equal","natural","quantile")
discitv <- c(4:6)
continuous_variable <- colnames(h1n1_100)[-c(1,11)]
## "gdm" function
h1n1gdm <- gdm(H1N1 ~ .,
              continuous_variable = continuous_variable,
              data = h1n1_100,
              discmethod = discmethod, discitv = discitv)

h1n1gdm
plot(h1n1gdm)

## End(Not run)

```

---

gdrisk

*Geographical detectors: risk detector.*


---

## Description

Function for risk detector calculation, risk matrix and visualization.

## Usage

```

gdrisk(formula, data = NULL)
## S3 method for class 'gdrisk'
print(x, ...)
## S3 method for class 'gdrisk'
plot(x, ...)

```

## Arguments

formula	A formula of response and explanatory variables
data	A data.frame includes response and explanatory variables
x	A list of risk detector results
...	Ignore

**Examples**

```
gr1 <- gdrisk(NDVIchange ~ Climatezone + Mining, data = ndvi_40)
gr1
plot(gr1)

data <- ndvi_40[,1:3]
gr2 <- gdrisk(NDVIchange ~ ., data = data)
gr2
```

---

H1N1

*Spatial datasets of H1N1 flu incidences*

---

**Description**

"H1N1" dataset is the provincial statistical incidences of influenza A virus subtype H1N1 in China in 2013. This dataset consists of H1N1 incidences and potential variables sampled from four sizes of spatial grid units, including 10 km, 20 km, 50 km and 100 km. The references of more details and data sources will be added.

**Usage**

h1n1\_50

h1n1\_100

h1n1\_150

**Format**

h1n1\_50: A data frame with 3977 rows and 11 variables  
h1n1\_100: A data frame with 987 rows and 11 variables  
h1n1\_150: A data frame with 443 rows and 11 variables

An object of class `data.frame` with 987 rows and 11 columns.

An object of class `data.frame` with 443 rows and 11 columns.

---

NDVI

*Spatial datasets of vegetation index changes.*

---

**Description**

"NDVI" dataset is the NDVI change data from 2010 to 2014 in Inner Mongolia, China. This dataset consists of NDVI change and potential variables sampled from six sizes of spatial grid units, including 5 km, 10 km, 20 km, 30 km, 40 km and 50 km. The references of more details and data sources will be added.

**Usage**

```
ndvi_5  
ndvi_10  
ndvi_20  
ndvi_30  
ndvi_40  
ndvi_50
```

**Format**

ndvi\_5: A data frame with 46295 rows and 7 variables  
ndvi\_10: A data frame with 11567 rows and 7 variables  
ndvi\_20: A data frame with 2892 rows and 7 variables  
ndvi\_30: A data frame with 1290 rows and 7 variables  
ndvi\_40: A data frame with 713 rows and 7 variables  
ndvi\_50: A data frame with 469 rows and 7 variables

An object of class `data.frame` with 11567 rows and 7 columns.

An object of class `data.frame` with 2892 rows and 7 columns.

An object of class `data.frame` with 1290 rows and 7 columns.

An object of class `data.frame` with 713 rows and 7 columns.

An object of class `data.frame` with 469 rows and 7 columns.

---

optidisc

*Optimal discretization for continuous variables and visualization.*

---

**Description**

Optimal discretization for continuous variables and visualization.

**Usage**

```
optidisc(formula, data,  
         discmethod = discmethod, discitv = discitv)  
## S3 method for class 'optidisc'  
print(x, ...)  
## S3 method for class 'optidisc'  
plot(x, ...)
```



**Arguments**

formula	A formula of response and explanatory variables, where the explanatory variables must be continuous variables to be discretized.
data	A data.frame includes response and explanatory variables
discmethod	A character vector of discretization methods
discitv	A numeric vector of numbers of intervals
x	A list of optidisc result
...	Ignore

**Examples**

```
## set optional discretization methods and numbers of intervals
# optional methods: equal, natural, quantile, geometric, sd and manual
discmethod <- c("equal","quantile")
discitv <- c(4:5)
## optimal discretization
odc1 <- optidisc(NDVIchange ~ Tempchange, ndvi_40, discmethod, discitv)
odc1
plot(odc1)
```

---

 riskmean

*Geographical detectors: risk means in risk detector.*


---

**Description**

Function for calculating risk means within intervals and visualization.

**Usage**

```
riskmean(formula, data = NULL)
## S3 method for class 'riskmean'
print(x, ...)
## S3 method for class 'riskmean'
plot(x, ...)
```

**Arguments**

formula	a formula of response and explanatory variables
data	a data.frame includes response and explanatory variables
x	a list of risk mean values
...	ignore

## Examples

```
rm1 <- riskmean(NDVIchange ~ Climatezone + Mining, data = ndvi_40)
rm1
plot(rm1)

data <- ndvi_40[,1:3]
rm2 <- riskmean(NDVIchange ~ ., data = data)
rm2
```

---

sesu

*Comparison of size effects of spatial units.*

---

## Description

Function for comparison of size effects of spatial units in spatial heterogeneity analysis.

## Usage

```
sesu(gdlist, su)
```

## Arguments

gdlist	A list of gdm result or gd result
su	A vector of sizes of spatial units

## Examples

```
ndvilist <- list(ndvi_30, ndvi_40, ndvi_50)
su <- c(30, 40, 50) ## sizes of spatial units
## "gdm" function
gdlist <- lapply(ndvilist, function(x){
  gdm(NDVIchange ~ Climatezone + Mining, data = x)
})
sesu(gdlist, su) ## size effects of spatial units
```

---

v2m	<i>Converts a vector to a lower triangular matrix.</i>
-----	--------------------------------------------------------

---

**Description**

The function `v2m` is used in the functions `gdrisk`, `gdinteract` and `gdeco` for converting a vector is from the results of the risk detector result, interaction detector result or ecological detector to a lower triangular matrix.

**Usage**

```
v2m(vec, diag = FALSE)
```

**Arguments**

<code>vec</code>	A data.frame of risk/interaction/ecological detector result of a strata variable
<code>diag</code>	TRUE/FALSE, indicating if the output matrix is a diagonal matrix.

# Index

- \* **H1N1**
  - H1N1, 7
- \* **NDVI**
  - NDVI, 7
- \* **datasets**
  - H1N1, 7
  - NDVI, 7
- \* **dataset**
  - H1N1, 7
  - NDVI, 7

disc, 2

gd, 3

gdeco, 3

gdinteract, 4

gdm, 5

gdrisk, 6

H1N1, 7

h1n1\_100 (H1N1), 7

h1n1\_150 (H1N1), 7

h1n1\_50 (H1N1), 7

NDVI, 7

ndvi\_10 (NDVI), 7

ndvi\_20 (NDVI), 7

ndvi\_30 (NDVI), 7

ndvi\_40 (NDVI), 7

ndvi\_5 (NDVI), 7

ndvi\_50 (NDVI), 7

optidisc, 8

plot.gd (gd), 3

plot.gdeco (gdeco), 3

plot.gdinteract (gdinteract), 4

plot.gdm (gdm), 5

plot.gdrisk (gdrisk), 6

plot.optidisc (optidisc), 8

plot.riskmean (riskmean), 9

print.gd (gd), 3

print.gdeco (gdeco), 3

print.gdinteract (gdinteract), 4

print.gdm (gdm), 5

print.gdrisk (gdrisk), 6

print.optidisc (optidisc), 8

print.riskmean (riskmean), 9

riskmean, 9

sesu, 10

v2m, 11