Package ‘latenetwork’

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Type Package
Title Inference on LATEs under Network Interference of Unknown Form
Version 1.0.1
Description Estimating causal parameters in the presence of treatment spillover is of great interest in statistics. This package provides tools for instrumental variables estimation of average causal effects under network interference of unknown form. The target parameters are the local average direct effect, the local average indirect effect, the local average overall effect, and the local average spillover effect. The methods are developed by Hoshino and Yanagi (2023) <doi:10.48550/arXiv.2108.07455>.
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**datageneration**

Generate Artificial Data by Simulation

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**Description**

The `datageneration()` function generates artificial ring-network data by simulation. The function is used in the package vignette.

**Usage**

`datageneration(n)`

**Arguments**

- `n` The sample size

**Value**

A list containing the outcome vector, the treatment vector, the instrumental vector, and the true instrumental exposure vector, and the symmetric binary adjacency matrix.

**Examples**

```r
latenetwork::datageneration(n = 2000)
```

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**direct**

Inference on Average Direct Effect Parameters

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**Description**

Inference on the average direct effect of the IV on the outcome, that on the treatment receipt, and the local average direct effect in the presence of network spillover of unknown form.
Usage

direct(
    Y,
    D,
    Z,
    IEM = NULL,
    S,
    A,
    K = 1,
    t = NULL,
    bw = NULL,
    B = NULL,
    alp = 0.05
)

Arguments

Y          An n-dimensional outcome vector
D          An n-dimensional binary treatment vector
Z          An n-dimensional binary instrumental vector
IEM        An n-dimensional instrumental exposure vector. If IEM = NULL or t = NULL, the constant IEM is used. Default is NULL.
S          An n-dimensional logical vector to indicate whether each unit belongs to the sub-population S
A          An n times n symmetric binary adjacency matrix
K          A scalar to indicate the range of neighborhood used for constructing the interference set. Default is 1. In the direct() function, K is used only for computing the bandwidth.
t          A scalar of the evaluation point of IEM. Default is NULL.
bw         A scalar of the bandwidth used for the HAC estimation and the wild bootstrap. If bw = NULL, the rule-of-thumb bandwidth proposed by Leung (2022) is used. Default is NULL.
B          The number of bootstrap repetitions. If B = NULL, the wild bootstrap is skipped. Default is NULL.
alp        The significance level. Default is 0.05.

Details

The direct() function estimates the average direct effect of the IV on the outcome, that on the treatment receipt, and the local average direct effect via inverse probability weighting in the approximate neighborhood interference framework. The function also computes the standard errors and the confidence intervals for the target parameters based on the network HAC estimation and the wild bootstrap. For more details, see Hoshino and Yanagi (2023). The lengths of Y, D, Z, S and of the row and column of A must be the same. IEM must be NULL or a vector of the same length as Y. t must be NULL or a value in the support of IEM. K must be a positive integer. bw must be NULL or a non-negative integer. B must be NULL or a positive number. alp must be a positive number between 0 and 0.5.
Value

A data.frame containing the following elements:

- **est**: The parameter estimate
- **HAC_SE**: The standard error computed by the network HAC estimation
- **HAC_CI_L**: The lower bound of the confidence interval computed by the network HAC estimation
- **HAC_CI_U**: The upper bound of the confidence interval computed by the network HAC estimation
- **wild_SE**: The standard error computed by the wild bootstrap
- **wild_CI_L**: The lower bound of the confidence interval computed by the wild bootstrap
- **wild_CI_U**: The upper bound of the confidence interval computed by the wild bootstrap
- **bw**: The bandwidth used for the HAC estimation and the wild bootstrap
- **size**: The size of the subpopulation S

References


Examples

```r
# Generate artificial data
set.seed(1)
n <- 2000
data <- latenetwork::datageneration(n = n)

# Arguments
Y <- data$Y
D <- data$D
Z <- data$Z
IEM <- data$IEM
S <- rep(TRUE, n)
A <- data$A
K <- 1
t <- 0
bw <- NULL
B <- NULL
alp <- 0.05

# Estimation
latenetwork::direct(Y = Y,
                    D = D,
                    Z = Z,
                    IEM = IEM,
                    S = S,
                    est = est,
                    HAC_SE = HAC_SE,
                    HAC_CI_L = HAC_CI_L,
                    HAC_CI_U = HAC_CI_U,
                    wild_SE = wild_SE,
                    wild_CI_L = wild_CI_L,
                    wild_CI_U = wild_CI_U,
                    bw = bw,
                    size = size)
```

\[
A = A, \\
K = K, \\
t = t, \\
 bw = bw, \\
B = B, \\
alp = alp
\]
Value

A data.frame containing the following elements:

- **est**: The parameter estimate
- **HAC_SE**: The standard error computed by the network HAC estimation
- **HAC_CI_L**: The lower bound of the confidence interval computed by the network HAC estimation
- **HAC_CI_U**: The upper bound of the confidence interval computed by the network HAC estimation
- **wild_SE**: The standard error computed by the wild bootstrap
- **wild_CI_L**: The lower bound of the confidence interval computed by the wild bootstrap
- **wild_CI_U**: The upper bound of the confidence interval computed by the wild bootstrap
- **bw**: The bandwidth used for the HAC estimation and the wild bootstrap
- **size**: The size of the subpopulation S

References


Examples

```r
# Generate artificial data
set.seed(1)
n <- 2000
data <- latenetwork::datageneration(n = n)

# Arguments
Y <- data$Y
D <- data$D
Z <- data$Z
S <- rep(TRUE, n)
A <- data$A
K <- 1
bw <- NULL
B <- NULL
alp <- 0.05

# Estimation
latenetwork::indirect(Y = Y, D = D, Z = Z, S = S, A = A, K = K, bw = bw)
```
overall(Y, D, Z, S, A, K = 1, bw = NULL, B = NULL, alp = 0.05)

Description

Inference on the average overall effect of the IV on the outcome, that on the treatment receipt, and
the local average overall effect in the presence of network spillover of unknown form

Usage

overall(Y, D, Z, S, A, K = 1, bw = NULL, B = NULL, alp = 0.05)

Arguments

Y: An n-dimensional outcome vector
D: An n-dimensional binary treatment vector
Z: An n-dimensional binary instrumental vector
S: An n-dimensional logical vector to indicate whether each unit belongs to the
sub-population S
A: An n times n symmetric binary adjacency matrix
K: A scalar to indicate the range of neighborhood used for constructing the inter-
ference set. Default is 1.
bw: A scalar of the bandwidth used for the HAC estimation and the wild bootstrap.
If bw = NULL, the rule-of-thumb bandwidth proposed by Leung (2022) is used.
Default is NULL.
B: The number of bootstrap repetitions. If B = NULL, the wild bootstrap is skipped.
Default is NULL.
alp: The significance level. Default is 0.05.

Details

The overall() function estimates the average overall effect of the IV on the outcome, that on
the treatment receipt, and the local average overall effect via inverse probability weighting in the
approximate neighborhood interference framework. The function also computes the standard errors
and the confidence intervals for the target parameters based on the network HAC estimation and
the wild bootstrap. For more details, see Hoshino and Yanagi (2023). The lengths of Y, D, Z, S and
of the row and column of A must be the same. K must be a positive integer. bw must be NULL or a
non-negative number. B must be NULL or a positive number. alp must be a positive number between
0 and 0.5.
Value

A data.frame containing the following elements:

- **est**: The parameter estimate
- **HAC_SE**: The standard error computed by the network HAC estimation
- **HAC_CI_L**: The lower bound of the confidence interval computed by the network HAC estimation
- **HAC_CI_U**: The upper bound of the confidence interval computed by the network HAC estimation
- **wild_SE**: The standard error computed by the wild bootstrap
- **wild_CI_L**: The lower bound of the confidence interval computed by the wild bootstrap
- **wild_CI_U**: The upper bound of the confidence interval computed by the wild bootstrap
- **bw**: The bandwidth used for the HAC estimation and the wild bootstrap
- **size**: The size of the subpopulation S

References


Examples

```r
# Generate artificial data
set.seed(1)
n <- 2000
data <- datagen::datageneration(n = n)

# Arguments
Y <- data$Y
D <- data$D
Z <- data$Z
S <- rep(TRUE, n)
A <- data$A
K <- 1
bw <- NULL
B <- NULL
alp <- 0.05

# Estimation
latnet::overall(Y = Y,
                D = D,
                Z = Z,
                S = S,
                A = A,
                K = K,
                bw = bw,
```
\begin{verbatim}
spillover = spillover(
    Y, 
    D, 
    Z, 
    IEM, 
    S, 
    A, 
    K = 1, 
    z, 
    t0, 
    t1, 
    bw = NULL, 
    B = NULL, 
    alp = 0.05
)
\end{verbatim}

**Description**

Inference on the average spillover effect of the IV on the outcome, that on the treatment receipt, and the local average spillover effect in the presence of network spillover of unknown form.

**Usage**

\begin{verbatim}
spillover(
    Y, 
    D, 
    Z, 
    IEM, 
    S, 
    A, 
    K = 1, 
    z, 
    t0, 
    t1, 
    bw = NULL, 
    B = NULL, 
    alp = 0.05
)
\end{verbatim}

**Arguments**

- **Y** An n-dimensional outcome vector
- **D** An n-dimensional binary treatment vector
- **Z** An n-dimensional binary instrumental vector
- **IEM** An n-dimensional instrumental exposure vector
- **S** An n-dimensional logical vector to indicate whether each unit belongs to the sub-population S
- **A** An n times n symmetric binary adjacency matrix
- **K** A scalar to indicate the range of neighborhood used for constructing the interference set. Default is 1. In the `spillover()` function, K is used only for computing the bandwidth.
- **z** A scalar of the evaluation point of Z
- **t0** A scalar of the evaluation point of instrumental exposure (from)
- **t1** A scalar of the evaluation point of instrumental exposure (to)
**bw** A scalar of the bandwidth used for the HAC estimation and the wild bootstrap. If bw = NULL, the rule-of-thumb bandwidth proposed by Leung (2022) is used. Default is NULL.

**B** The number of bootstrap repetitions. If B = NULL, wild bootstrap is skipped. Default is NULL.

**alp** The significance level. Default is 0.05.

**Details**

The `spillover()` function estimates the average spillover effect of the IV on the outcome, that on the treatment receipt, and the local average spillover effect via inverse probability weighting in the approximate neighborhood interference framework. The function also computes the standard errors and the confidence intervals for the target parameters based on the network HAC estimation and the wild bootstrap. For more details, see Hoshino and Yanagi (2023). The lengths of Y, D, Z, IEM, S and of the row and column of A must be the same. z must be 0 or 1. t0 and t1 must be values in the support of IEM. bw must be NULL or a non-negative number. B must be NULL or a positive integer. alp must be a positive number between 0 and 0.5.

**Value**

A data frame containing the following elements:

- est The parameter estimate
- HAC_SE The standard error computed by the network HAC estimation
- HAC_CI.L The lower bound of the confidence interval computed by the network HAC estimation
- HAC_CI.U The upper bound of the confidence interval computed by the network HAC estimation
- wild_SE The standard error computed by the wild bootstrap
- wild_CI.L The lower bound of the confidence interval computed by the wild bootstrap
- wild_CI.U The upper bound of the confidence interval computed by the wild bootstrap
- bw The bandwidth used for the HAC estimation and the wild bootstrap
- size The size of the subpopulation S

**References**


**Examples**

```r
# Generate artificial data
set.seed(1)
n <- 2000
data <- latenetwork::datageneration(n = n)
```
# Arguments
Y <- data$Y
D <- data$D
Z <- data$Z
S <- rep(TRUE, n)
A <- data$A
K <- 1
IEM <- ifelse(A %*% Z > 0, 1, 0)
z <- 1
t0 <- 0
t1 <- 1
bw <- NULL
B <- NULL
alp <- 0.05

# Estimation
latenetwork::spillover(Y = Y,
D = D,
Z = Z,
IEM = IEM,
S = S,
A = A,
K = K,
z = z,
t0 = t0,
t1 = t1,
bw = bw,
B = B,
alp = alp)
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