# Package ‘gwrr’

October 13, 2022

**Type**  Package

**Title**  Fits Geographically Weighted Regression Models with Diagnostic Tools

**Version**  0.2-2

**Date**  2022-05-09

**Author**  David Wheeler

**Maintainer**  David Wheeler &lt;dcwheels@gmail.com&gt;

**Depends**  fields, lars

**Description**  Fits geographically weighted regression (GWR) models and has tools to diagnose and remediate collinearity in the GWR models. Also fits geographically weighted ridge regression (GWRR) and geographically weighted lasso (GWL) models. See Wheeler (2009) &lt;doi:10.1068/a40256&gt; and Wheeler (2007) &lt;doi:10.1068/a38325&gt; for more details.

**License**  GPL (&gt;= 2)

**LazyLoad**  yes

**NeedsCompilation**  no

**Repository**  CRAN

**Date/Publication**  2022-05-10 06:50:02 UTC

## R topics documented:

- gwrr-package ................................................................. 2
- columbus ................................................................. 3
- gwl.est ................................................................. 4
- gwr.bw.est ............................................................. 5
- gwr.est ................................................................. 6
- gwr.vdp ................................................................. 8
- gwrr.est ............................................................... 9

**Index**  12
Geographically weighted regression models with penalties and diagnostic tools

Description

Fits geographically weighted regression (GWR) models and has tools to diagnose collinearity in the GWR models. Also fits geographically weighted ridge regression (GWRR) and geographically weighted lasso (GWL) models.

Details

Package: gwrr
Type: Package
Version: 0.2-1
Date: 2013-06-11
License: GPL (>=2)
LazyLoad: yes

Author(s)

David Wheeler
Maintainer: David Wheeler <dcwheels@gmail.com>

References


Examples

data(columbus)
locs <- cbind(columbus$x, columbus$y)
col.gwr <- gwr.est(crime ~ income + houseval, locs, columbus, "exp")
plot(col.gwr$beta[2,], col.gwr$beta[3,])
col.vdp <- gwr.vdp(crime ~ income + houseval, locs, columbus, col.gwr$phi, "exp")
hist(col.vdp$condition)
**columbus**

---

<table>
<thead>
<tr>
<th>columbus</th>
<th>Columbus crime</th>
</tr>
</thead>
</table>

**Description**

Crime rate in planning neighborhoods in Columbus, Ohio in 1980

**Usage**

data(columbus)

**Format**

A data frame with 49 observations on the following 6 variables.

- houseval: a numeric vector
- income: a numeric vector
- crime: a numeric vector
- distcbd: a numeric vector
- x: a numeric vector
- y: a numeric vector

**Details**

The data consist of variables for mean housing value, mean household income, residential and vehicle thefts combined per thousand people for 1980, distance to the central business district (CBD), and x and y spatial coordinates of neighborhood centroids.

**Source**


**References**


**Examples**

data(columbus)
plot(columbus$x, columbus$y)
**gwl.est**  
*Geographically weighted lasso*

**Description**

This function fits a geographically weighted lasso (GWL) model

**Usage**

```
gwl.est(form, locs, data, kernel = "exp", cv.tol)
```

**Arguments**

- **form**: A regression model formula, as in the functions `lm` and `glm`
- **locs**: A matrix of spatial coordinates of data points, where the x coordinate is first, then the y coordinate; coordinates are assumed to not be latitude and longitude, as Euclidean distance is calculated from coordinates
- **data**: A data frame with data to fit model
- **kernel**: A kernel weighting function, either `exp` or `gauss`, where exponential function is default
- **cv.tol**: A stopping tolerance in terms of cross-validation error for the bi-section search routine to estimate the kernel bandwidth using cross-validation; if missing an internally calculated value is used

**Details**

This function estimates penalized spatially varying coefficients using the geographically weighted regression and lasso approaches. Spatial kernel weights are applied to observations using the estimated kernel bandwidth to estimate local models at each data point. The kernel bandwidth and lasso solutions are currently estimated using cross-validation with an exponential or Gaussian kernel function. Some regression coefficients may be penalized to zero. The function estimates regression coefficients, the outcome variable values, and the model fit.

**Value**

A list with the following items:

- **phi**: Kernel bandwidth
- **RMSPE**: Root mean squared prediction error from bandwidth estimation
- **beta**: Matrix of estimated regression coefficients, where a row contains the coefficients for one regression term for all data points
- **yhat**: Estimated outcome variable values
- **RMSE**: Root mean squared error from estimation
- **rsquare**: Approximate R-square for GWR model
gwr.bw.est

Author(s)

David Wheeler

References


See Also

gwrr.est

Examples

data(columbus)
locs <- cbind(columbus$x, columbus$y)
col.gwl <- gwrr.est(crime ~ income + houseval, locs, columbus, "exp")
plot(col.gwl$beta[2,], col.gwl$beta[3,])
plot(columbus$x, columbus$y, cex=col.gwl$beta[1,]/10)

Description

Estimate the kernel function bandwidth with cross-validation

Usage

gwr.bw.est(form, locs, data, kernel = "exp", cv.tol)

Arguments

form A regression model forumula, as in the functions lm and glm
locs A matrix of spatial coordinates of data points, where the x coordinate is first, then the y coordinate; coordinates are assumed to not be latitude and longitude, as Euclidean distance is calculated from coordinates
data A data frame with data to fit model
kernel A kernel weighting function, either exp or gauss, where exponential function is default
cv.tol A stopping tolerance in terms of cross-validation error for the bi-section search routine to estimate the kernel bandwidth using cross-validation; if missing an internally calculated value is used
Details

This function estimates the kernel bandwidth in a GWR model with leave-one-out cross-validation. It does not estimate the final regression coefficients or outcome variable.

Value

A list with the following items:

- **phi**: Kernel bandwidth
- **RMSPE**: Root mean squared prediction error from bandwidth estimation
- **cv.score**: Sum of squared prediction errors from bandwidth estimation

Author(s)

David Wheeler

References


See Also

gwr.est

Examples

data(columbus)
locs <- cbind(columbus$x, columbus$y)
col.bw <- gwr.bw.est(crime ~ income + houseval, locs, columbus, "exp")
col.gwr <- gwr.est(crime ~ income + houseval, locs, columbus, "exp", bw=col.bw$phi)

---

**gwr.est**

*Geographically weighted regression*

Description

This function fits a geographically weighted regression (GWR) model

Usage

gwr.est(form, locs, data, kernel = "exp", bw = TRUE, cv.tol)
Arguments

- **form**: A regression model formula, as in the functions lm and glm
- **locs**: A matrix of spatial coordinates of data points, where the x coordinate is first, then the y coordinate; coordinates are assumed to not be latitude and longitude, as Euclidean distance is calculated from coordinates
- **data**: A data frame with data to fit model
- **kernel**: A kernel weighting function, either exp or gauss, where exponential function is default
- **bw**: Either TRUE to estimate a bandwidth for the kernel function, or the bandwidth to use to fit the model; bandwidth is estimated by default
- **cv.tol**: A stopping tolerance in terms of cross-validation error for the bi-section search routine to estimate the kernel bandwidth using cross-validation; if missing an internally calculated value is used

Details

This function estimates spatially varying coefficients using the GWR approach. Spatial kernel weights are applied to observations using the estimated or supplied kernel bandwidth to estimate local models at each data point. The bandwidth is currently estimated with cross-validation with an exponential or Gaussian kernel function. The function estimates regression coefficients, the outcome variable values, and the model fit.

Value

A list with the following items:

- **phi**: Kernel bandwidth
- **RMSPE**: Root mean squared prediction error from bandwidth estimation
- **beta**: Matrix of estimated regression coefficients, where a row contains the coefficients for one regression term for all data points
- **yhat**: Estimated outcome variable values
- **RMSE**: Root mean squared error from estimation
- **rsquare**: Approximate R-square for GWR model

Author(s)

David Wheeler

References


See Also

gwr.bw.est
Examples

data(columbus)
locs <- cbind(columbus$x, columbus$y)
col.gwr <- gwr.est(crime ~ income + houseval, locs, columbus, "exp")
plot(col.gwr$beta[2,], col.gwr$beta[3,])
plot(columbus$x, columbus$y, cex=col.gwr$beta[1,]/10)

gwr.vdp

Collinearity diagnostics for geographically weighted regression

Description

Uses the collinearity diagnostic tools of variance-decomposition proportions and condition indexes for geographically weighted regression (GWR) models.

Usage

gwr.vdp(form, locs, data, phi, kernel = "exp", sel.ci = 30, sel.vdp = 0.5)

Arguments

form A regression model forumula, as in the functions lm and glm
locs A matrix of spatial coordinates of data points, where the x coordinate is first, then the y coordinate; coordinates are assumed to not be latitude and longitude, as Euclidean distance is calculated from coordinates
data A data frame with data to fit model
phi The kernel bandwidth used in the GWR model
kernel The kernel weighting function used in the GWR model, either exp or gauss; exp is the default
sel.ci The threshold value to use for the condition index to indicate observations with a collinearity issue; indexes above this value will be flagged; the default is 30
sel.vdp The threshold value to use for the variance-decomposition proportion to indicate observations with a collinearity issue; proportions above this value will be flagged; the default is 0.5

Details

This function calculates the variance-decomposition proportions and the condition indexes for the weighted design matrix used in a GWR model. The kernel function and bandwidth used to estimate the GWR model must be input to this function. Observations with a large condition index and relatively large variance-decomposition proportions for more than one regression term indicate an issue with collinearity.
**Value**

A list with the following items:

- **condition**: Largest condition index for each observation
- **vdp**: Variance-decomposition proportions for the largest variance component for each observation
- **flag.cond**: True if largest condition index exceeds threshold
- **flag.vdp**: True if variance-decomposition proportions for more than one term exceed threshold
- **flag.cond.vdp**: True if condition index and variance-decomposition proportions exceed thresholds

**Author(s)**

David Wheeler

**References**


**See Also**

- `gwr.bw.est`

**Examples**

```r
data(columbus)
llocs <- cbind(columbus$x, columbus$y)
col.bw <- gwr.bw.est(crime ~ income + houseval, locs, columbus, "exp")
col.vdp <- gwr.vdp(crime ~ income + houseval, locs, columbus, col.bw$phi, "exp")
hist(col.vdp$condition)
```

---

**Description**

This function fits a geographically weighted ridge regression (GWRR) model

**Usage**

```r
gwrr.est(form, locs, data, kernel = "exp", bw = TRUE, rd = TRUE, cv.tol)
```
Arguments

form
A regression model formula, as in the functions lm and glm

locs
A matrix of spatial coordinates of data points, where the x coordinate is first, then the y coordinate; coordinates are assumed to not be latitude and longitude, as Euclidean distance is calculated from coordinates

data
A data frame with data to fit model

kernel
A kernel weighting function, either exp or gauss, where exponential function is default

bw
Either TRUE to estimate a bandwidth for the kernel function, or the bandwidth to use to fit the model; bandwidth is estimated by default

rd
Either TRUE to estimate a ridge shrinkage parameter, or the ridge parameter to use to fit the model; ridge parameter is estimated by default

cv.tol
A stopping tolerance in terms of cross-validation error for the bi-section search routine to estimate the kernel bandwidth using cross-validation; if missing an internally calculated value is used

Details

This function estimates penalized spatially varying coefficients using the GWR and ridge regression approaches. Spatial kernel weights are applied to observations using the estimated or supplied kernel bandwidth to estimate local models at each data point. The bandwidth is estimated with cross-validation with an exponential or Gaussian kernel function. The regression coefficients are penalized with a ridge parameter that is estimated with cross-validation. The function estimates regression coefficients, the outcome variable values, and the model fit.

Value

A list with the following items:

phi
Kernel bandwidth

lambda
Ridge shrinkage parameter

RMSPE
Root mean squared prediction error from bandwidth estimation

beta
Matrix of estimated regression coefficients, where a row contains the coefficients for one regression term for all data points

yhat
Estimated outcome variable values

RMSE
Root mean squared error from estimation

rsquare
Approximate R-square for GWR model

Author(s)

David Wheeler

References

See Also

`gwr.est`

Examples

```r
data(columbus)
locs <- cbind(columbus$x, columbus$y)
col.gwrr <- gwrr.est(crime ~ income + houseval, locs, columbus, "exp", bw=2.00, rd=0.03)
plot(col.gwrr$beta[2,], col.gwrr$beta[3,])
plot(columbus$x, columbus$y, cex=col.gwrr$beta[1,]/10)
col.gwr <- gwr.est(crime ~ income + houseval, locs, columbus, "exp", bw=col.gwrr$phi, rd=0)
```
Index

* datasets
  columbus, 3

* models
  gwl.est, 4
  gwr.bw.est, 5
  gwr.est, 6
  gwrr.est, 9

* multivariate
  gwr.vdp, 8

* package
  gwrr-package, 2