Package 'rgeoprofile'

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Type Package

Title Geographic Profiling Methods for Serial Crime Analysis

Version 0.2.0

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Description An implementation of functions for the analysis of serial crime incidents. The package implements algorithms for the geographical profiling of serial incidents in attempt to prioritize the area in which the anchor point or home base of the perpetrator is located. The geographic profiling methods in the package are implemented based upon the 'Dragnet' software by Canter, Coffey, Huntley, and Missen (2000) <doi:10.1023/A:1007551316253>, the 'CrimeStat' software by Levine (2013) <https://nij.ojp.gov/topics/articles/crimestat-spatial-statistics-program-analysis-crime-incident-locations>, and the criminal geographic targeting model outlined in Rossmo (2000, ISBN:978-0849381294) and Rossmo (1995) <http://summit.sfu.ca/item/6820>.

Depends R (>= 3.5.0)

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 7.1.0

Imports aspace, geosphere, grDevices, leaflet, pals, RANN, raster, sp, spatstat, splancs, utils

Suggests htmlwidgets, leafsync, knitr, rgdal, rmarkdown

VignetteBuilder knitr

NeedsCompilation no

Repository CRAN

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R topics documented:

`cgt_profile` *Criminal Geographic Targeting Model for Geographic Profiling (Rossmo Formula)*

Description

An implementation of the criminal geographic targeting model for serial crime analysis developed by DK Rossmo. This function applies Rossmo's distance decay formula to a series of suspected crime incidents for geographic profiling and prediction of perpetrator home base.

Usage

```
cgt_profile(lat, lon, buffer = NULL, f = NULL, g = NULL, n = NULL)
```

Arguments

`lat`	a vector of latitudes for the crime incident series
`lon`	a vector of latitudes for the crime incident series
`buffer`	the radius for the buffer zone assumed by the distance decay model.
`f`	decay formula coefficient which changes the steepness of the decay curve after the buffer radius. If `NULL`, the default value for '*f*' is 1.2 as recommended by Rossmo (1995)
`g`	decay formula coefficient which changes the steepness of the decay curve before the buffer radius. If `NULL`, the default value for '*g*' is 1.2 as recommended by Rossmo (1995)
`n`	total number of cells within the spatial grid for the jeopardy surface. If `NULL`, the default value for '*n*' is 40,000.

Value

A data frame of points depicting a spatial grid of the hunting area for the given incident locations. Also given are the resultant summed values (score) for each map point. A higher resultant score indicates a greater the probability that point contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

References

DK Rossmo (2000). *Geographic profiling. Boca Raton, FL: CRC Press.*

DK Rossmo (1995). *Geographic profiling: Target patterns of serial murderers.* Diss. Theses (School of Criminology)/Simon Fraser University.

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
test <- cgt_profile(desalvo$lat, desalvo$lon)
g_map = sp::SpatialPixelsDataFrame(points = test[c("lons", "lats")], data = test)
g_map <- raster::raster(g_map)
# Assign a Coordinate Reference System for the Raster
raster::crs(g_map) <- sp::CRS("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
# Define a Parula Color Pallete for Resultant Jeopardy Surface
library(leaflet) #for mapping the geographic profile
pal <- colorNumeric(pals::parula(200), raster::values(g_map),
    na.color = "transparent")
leaflet() %>%
    addTiles() %>%
    addProviderTiles('Esri.WorldTopoMap', group = 'Topo') %>%
    addAwesomeMarkers(lng = -71.07357, lat = 42.41322, icon =
        awesomeIcons(icon = 'home', markerColor = 'green'), popup = 'Residence') %>%
    addRasterImage(g_map, colors = pal, opacity = 0.6) %>%
    addLegend(pal = pal, values = raster::values(g_map), title = 'Score') %>%
    addCircleMarkers(lng = desalvo$lon, lat = desalvo$lat, radius = 4, opacity = 1,
        fill = 'black', stroke = TRUE, fillOpacity = 0.75, weight = 2,
        fillColor = "red")
```

`circle_center` *Center of the Circle Calculation for Geographic Profiling*

Description

A calculation for the center of the circle which bounds the incident coordinates for serial crime analysis. This function is among the centrographic methods which have been used for geographic profiling. The model assumes that the serial perpetrator's home base is relatively central among the crime incidents.

Usage

```
circle_center(lat, lon)
```

Arguments

lat	a vector of latitudes for the crime incident series
lon	a vector of latitudes for the crime incident series

Value

A latitude and longitude coordinate for the center of the circle which encompasses the incidents. This point can be used to prioritize the area which contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
circle_center(desalvo$lat, desalvo$lon)
```

---

cmd_pred *Calculation of Center of Minimum Distance for Geographic Profiling*

Description

A calculation of the center of minimum distance for serial crime analysis. This function is among the centrographic methods which have been used for geographic profiling. The model assumes that the serial perpetrator's home base is relatively central among the crime incidents.

Usage

```
cmd_pred(lat, lon)
```

Arguments

lat	a vector of latitudes for the crime incident series
lon	a vector of latitudes for the crime incident series

Value

A latitude and longitude point of the center of minimum distance of the incidents. This mean can be used to prioritize the area which contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
cmd_pred(desalvo$lat, desalvo$lon)
```

---

desalvo *Incidents from the Boston Strangler Case (Albert DeSalvo)*

Description

A sample dataset of serial crimes for analysis (Boston Strangler)

Usage

```
desalvo
```

Format

A data frame with 13 rows and 5 variables.

name Victim name.

age Age of the victim.

date Date when the incident occurred.

lat The latitude of the location where the incident occurred.

lon The longitude of the location where the incident occurred.

geom_mean_pred *Calculation of Geometric Mean for Geographic Profiling*

Description

A calculation of the geometric mean for serial crime analysis. This function is among the centrographic methods which have been used for geographic profiling. The model assumes that the serial perpetrator's home base is relatively central among the crime incidents.

Usage

```
geom_mean_pred(lat, lon)
```

Arguments

lat	a vector of latitudes for the crime incident series
lon	a vector of latitudes for the crime incident series

Value

A latitude and longitude point of the geometric mean of the incidents. This mean can be used to prioritize the area which contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
geom_mean_pred(desalvo$lat, desalvo$lon)
```

harm_mean_pred *Calculation of Harmonic Mean for Geographic Profiling*

Description

A calculation of the harmonic mean for serial crime analysis. This function is among the centrographic methods which have been used for geographic profiling. The model assumes that the serial perpetrator's home base is relatively central among the crime incidents.

Usage

```
harm_mean_pred(lat, lon)
```

Arguments

lat	a vector of latitudes for the crime incident series
lon	a vector of latitudes for the crime incident series

Value

A latitude and longitude point of the harmonic mean of the incidents. This mean can be used to prioritize the area which contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
harm_mean_pred(desalvo$lat, desalvo$lon)
```

---

linear_profile *CrimeStat Linear Model for Geographic Profiling*

Description

An implementation of the linear decay model for serial crime analysis within 'CrimeStat'. This model assumes that the likelihood of the serial perpetrator's home base decreases in a linear fashion as the distance increases from the crime incidents.

Usage

```
linear_profile(lat, lon, a = NULL, b = NULL, n = NULL)
```

Arguments

lat	a vector of latitudes for the crime incident series
lon	a vector of latitudes for the crime incident series
a	the slope coefficient which defines the function decrease in distance. If NULL, the default value for '*a*' is 1.9 (Levine 2013)
b	a constant for the distance decay function If NULL, the default value for '*b*' is -0.06 (Levine 2013)
n	total number of cells within the spatial grid for the jeopardy surface. If NULL, the default value for '*n*' is 40,000.

Value

A data frame of points depicting a spatial grid of the hunting area for the given incident locations. Also given are the resultant summed values (score) for each map point. A higher resultant score indicates a greater the probability that point contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

References

Ned Levine, *CrimeStat IV: A Spatial Statistics Program for the Analysis of Crime Incident Locations (version 4.0)*. Ned Levine & Associates, Houston, TX, and the National Institute of Justice, Washington, DC, June 2013.

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
test <- linear_profile(desalvo$lat, desalvo$lon)
g_map = sp::SpatialPixelsDataFrame(points = test[c("lons", "lats")], data = test)
g_map <- raster::raster(g_map)
# Assign a Coordinate Reference System for the Raster
raster::crs(g_map) <- sp::CRS("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
# Define a Parula Color Pallete for Resultant Jeopardy Surface
library(leaflet) #for mapping the geographic profile
pal <- colorNumeric(pals::parula(200), raster::values(g_map),
    na.color = "transparent")
leaflet() %>%
    addTiles() %>%
    addProviderTiles('Esri.WorldTopoMap', group = 'Topo') %>%
    addAwesomeMarkers(lng = -71.07357, lat = 42.41322, icon =
        awesomeIcons(icon = 'home', markerColor = 'green'), popup = 'Residence') %>%
    addRasterImage(g_map, colors = pal, opacity = 0.6) %>%
    addLegend(pal = pal, values = raster::values(g_map), title = 'Score') %>%
    addCircleMarkers(lng = desalvo$lon, lat = desalvo$lat, radius = 4, opacity = 1,
        fill = 'black', stroke = TRUE, fillOpacity = 0.75, weight = 2,
        fillColor = "red")
```

`lognorm_profile` *CrimeStat Lognormal Model for Geographic Profiling*

Description

An implementation of the lognormal decay model for serial crime analysis within 'CrimeStat'. This model is very similar to the normal model except with more skew to either side. If there is reason to believe that the perpetrator's residence is closer to the incidents, this function can take the form of a very rapid increase near incident with a gradual decline from the peak likelihood.

Usage

```
lognorm_profile(lat, lon, a = NULL, d_mean = NULL, sd = NULL, n = NULL)
```

Arguments

lat	a vector of latitudes for the crime incident series
lon	a vector of latitudes for the crime incident series
a	coefficient for the normal decay function. If NULL, the default value for 'a' is 8.6 (Levine 2013)
d_mean	mean distance. If NULL, the default value for 'd_mean' is 4.2 (Levine 2013)
sd	standard deviation of the distances. If NULL, the default value for 'sd' is 4.6 (Levine 2013)
n	total number of cells within the spatial grid for the jeopardy surface. If NULL, the default value for '*n*' is 40,000.

Value

A data frame of points depicting a spatial grid of the hunting area for the given incident locations. Also given are the resultant summed values (score) for each map point. A higher resultant score indicates a greater the probability that point contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

References

Ned Levine, *CrimeStat IV: A Spatial Statistics Program for the Analysis of Crime Incident Locations (version 4.0).* Ned Levine & Associates, Houston, TX, and the National Institute of Justice, Washington, DC, June 2013.

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
test <- lognorm_profile(desalvo$lat, desalvo$lon)
g_map = sp::SpatialPixelsDataFrame(points = test[c("lons", "lats")], data = test)
g_map <- raster::raster(g_map)
# Assign a Coordinate Reference System for the Raster
```

```
raster::crs(g_map) <- sp::CRS("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
# Define a Parula Color Pallete for Resultant Jeopardy Surface
library(leaflet) #for mapping the geographic profile
pal <- colorNumeric(pals::parula(200), raster::values(g_map),
    na.color = "transparent")
leaflet() %>%
    addTiles() %>%
    addProviderTiles('Esri.WorldTopoMap', group = 'Topo') %>%
    addAwesomeMarkers(lng = -71.07357, lat = 42.41322, icon =
        awesomeIcons(icon = 'home', markerColor = 'green'), popup = 'Residence') %>%
    addRasterImage(g_map, colors = pal, opacity = 0.6) %>%
    addLegend(pal = pal, values = raster::values(g_map), title = 'Score') %>%
    addCircleMarkers(lng = desalvo$lon, lat = desalvo$lat, radius = 4, opacity = 1,
        fill = 'black', stroke = TRUE, fillOpacity = 0.75, weight = 2,
        fillColor = "red")
```

`neg_exp_profile` *Negative Exponential Model for Geographic Profiling*

Description

An implementation of variations of the negative exponential decay model for serial crime analysis. In this model, the decline is at a constant rate, therefore the likelihood of the perpetrator's home base drops quickly from the incident locations until it approaches zero likelihood. The user can select different variants including the 'CrimeStat' base model, the 'Dragnet' model, or whether a buffer and plateau is present at the start of the decay function. This model assumes that the likelihood of the serial perpetrator's home base decreases in a exponential fashion as the distance increases from the crime incidents.

Usage

```
neg_exp_profile(
  lat,
  lon,
  method = c("CrimeStat", "Dragnet", "Custom"),
  buffer = FALSE,
  a = NULL,
  b = NULL,
  n = NULL
)
```

Arguments

`lat`	a vector of latitudes for the crime incident series
`lon`	a vector of latitudes for the crime incident series

method	'CrimeStat', 'Dragnet', or a custom parameter based negative exponential decay function. If using the 'CrimeStat' or 'Dragnet' method, values do not need to be provided from 'a' and 'b' as the default parameters will be used. Default parameters for the 'CrimeStat' are: $a = 1.89$ $a = -0.06$. Default parameters for the 'Dragnet' are: $a = b = 1$. If using a custom model, values must be provided for '*a*' and '*b*'.
buffer	TRUE/FALSE. Whether a buffer zone where a likelihood of zero is fit around the incidents and a plateau of peak likelihood is fit prior to the negative exponential decay. The function calculates the buffer zone and the plateau area to each be half of the average nearest neighbor distance.
a	the slope coefficient which defines the function decrease in distance
b	exponential multiplier for the distance decay function
n	total number of cells within the spatial grid for the jeopardy surface. If NULL, the default value for '*n*' is 40,000.

Value

A data frame of points depicting a spatial grid of the hunting area for the given incident locations. Also given are the resultant summed values (score) for each map point. A higher resultant score indicates a greater the probability that point contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

References

Ned Levine, *CrimeStat IV: A Spatial Statistics Program for the Analysis of Crime Incident Locations (version 4.0).* Ned Levine & Associates, Houston, TX, and the National Institute of Justice, Washington, DC, June 2013.

D Canter, T Coffey, M Huntley & C Missen. (2000). *Predicting serial killers' home base using a decision support system.* Journal of quantitative criminology, 16(4), 457-478.

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
test <- neg_exp_profile(desalvo$lat, desalvo$lon, method = "CrimeStat")
g_map = sp::SpatialPixelsDataFrame(points = test[c("lons", "lats")], data = test)
g_map <- raster::raster(g_map)
# Assign a Coordinate Reference System for the Raster
raster::crs(g_map) <- sp::CRS("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
# Define a Parula Color Pallete for Resultant Jeopardy Surface
library(leaflet) #for mapping the geographic profile
pal <- colorNumeric(pals::parula(200), raster::values(g_map),
    na.color = "transparent")
leaflet() %>%
```

```
addTiles() %>%
addProviderTiles('Esri.WorldTopoMap', group = 'Topo') %>%
addAwesomeMarkers(lng = -71.07357, lat = 42.41322, icon =
    awesomeIcons(icon = 'home', markerColor = 'green'), popup = 'Residence') %>%
addRasterImage(g_map, colors = pal, opacity = 0.6) %>%
addLegend(pal = pal, values = raster::values(g_map), title = 'Score') %>%
addCircleMarkers(lng = desalvo$lon, lat = desalvo$lat, radius = 4, opacity = 1,
    fill = 'black', stroke = TRUE, fillOpacity = 0.75, weight = 2,
    fillColor = "red")
```

`norm_profile` *CrimeStat Normal Model for Geographic Profiling*

Description

An implementation of the normal decay model for serial crime analysis within 'CrimeStat'. This model assumes that there is a peak likelihood of the serial perpetrator's home base at some optimal distance from the crime incidents. The function rises in likelihood to that distance and then declines at an equal rate (both prior to and after the peak likelhihood) giving the symetrical normal distribution.

Usage

```
norm_profile(lat, lon, a = NULL, d_mean = NULL, sd = NULL, n = NULL)
```

Arguments

`lat`	a vector of latitudes for the crime incident series
`lon`	a vector of latitudes for the crime incident series
`a`	coefficient for the normal decay function. If `NULL`, the default value for 'a' is 29.5 (Levine 2013)
`d_mean`	mean distance. If `NULL`, the default value for 'd_mean' is 4.2 (Levine 2013)
`sd`	standard deviation of the distances. If `NULL`, the default value for 'sd' is 4.6 (Levine 2013)
`n`	total number of cells within the spatial grid for the jeopardy surface. If `NULL`, the default value for '*n*' is 40,000.

Value

A data frame of points depicting a spatial grid of the hunting area for the given incident locations. Also given are the resultant summed values (score) for each map point. A higher resultant score indicates a greater the probability that point contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

References

Ned Levine, *CrimeStat IV: A Spatial Statistics Program for the Analysis of Crime Incident Locations (version 4.0)*. Ned Levine & Associates, Houston, TX, and the National Institute of Justice, Washington, DC, June 2013.

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
test <- norm_profile(desalvo$lat, desalvo$lon)
g_map = sp::SpatialPixelsDataFrame(points = test[c("lons", "lats")], data = test)
g_map <- raster::raster(g_map)
# Assign a Coordinate Reference System for the Raster
raster::crs(g_map) <- sp::CRS("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
# Define a Parula Color Pallete for Resultant Jeopardy Surface
library(leaflet) #for mapping the geographic profile
pal <- colorNumeric(pals::parula(200), raster::values(g_map),
    na.color = "transparent")
leaflet() %>%
    addTiles() %>%
    addProviderTiles('Esri.WorldTopoMap', group = 'Topo') %>%
    addAwesomeMarkers(lng = -71.07357, lat = 42.41322, icon =
        awesomeIcons(icon = 'home', markerColor = 'green'), popup = 'Residence') %>%
    addRasterImage(g_map, colors = pal, opacity = 0.6) %>%
    addLegend(pal = pal, values = raster::values(g_map), title = 'Score') %>%
    addCircleMarkers(lng = desalvo$lon, lat = desalvo$lat, radius = 4, opacity = 1,
        fill = 'black', stroke = TRUE, fillOpacity = 0.75, weight = 2,
        fillColor = "red")
```

---

trun_neg_exp_profile *CrimeStat Truncated Negative Exponential Model for Geographic Profiling*

Description

An implementation of the truncated negative exponential decay model for serial crime analysis within 'CrimeStat'. This is a joint function composed of both the linear and the negative exponential. For distances proximal to the incidents, a positive linear function is defined from zero likelihood at distance zero to a location of peak likelihood. At the peak likelihood the function takes the form of a negative exponential, rapidly declining as distance increases.

Usage

```
trun_neg_exp_profile(lat, lon, dp = NULL, peak_lh = NULL, c = NULL, n = NULL)
```

Arguments

lat	a vector of latitudes for the crime incident series
lon	a vector of latitudes for the crime incident series
dp	radial distance for the peak likelihood (cutoff distance). If NULL, the default value for 'dp' is 4.2 (Levine 2013)
peak_lh	peak likelihood for the distance decay function. If NULL, the default value for 'peak_lh' is 13.8 (Levine 2013)
c	exponential constant for the negative exponential decay function. If NULL, the default value for 'c' is -0.06 (Levine 2013)
n	total number of cells within the spatial grid for the jeopardy surface. If NULL, the default value for '*n*' is 40,000.

Value

A data frame of points depicting a spatial grid of the hunting area for the given incident locations. Also given are the resultant summed values (score) for each map point. A higher resultant score indicates a greater the probability that point contains the offender's anchor point.

Author(s)

Jamie Spaulding, Keith Morris

References

Ned Levine, *CrimeStat IV: A Spatial Statistics Program for the Analysis of Crime Incident Locations (version 4.0).* Ned Levine & Associates, Houston, TX, and the National Institute of Justice, Washington, DC, June 2013.

Examples

```
#Using provided dataset for the Boston Strangler Incidents:
data(desalvo)
test <- trun_neg_exp_profile(desalvo$lat, desalvo$lon)
g_map = sp::SpatialPixelsDataFrame(points = test[c("lons", "lats")], data = test)
g_map <- raster::raster(g_map)
# Assign a Coordinate Reference System for the Raster
raster::crs(g_map) <- sp::CRS("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
# Define a Parula Color Pallete for Resultant Jeopardy Surface
library(leaflet) #for mapping the geographic profile
pal <- colorNumeric(pals::parula(200), raster::values(g_map),
    na.color = "transparent")
leaflet() %>%
    addTiles() %>%
    addProviderTiles('Esri.WorldTopoMap', group = 'Topo') %>%
    addAwesomeMarkers(lng = -71.07357, lat = 42.41322, icon =
        awesomeIcons(icon = 'home', markerColor = 'green'), popup = 'Residence') %>%
    addRasterImage(g_map, colors = pal, opacity = 0.6) %>%
```

```
    addLegend(pal = pal, values = raster::values(g_map), title = 'Score') %>%
    addCircleMarkers(lng = desalvo$lon, lat = desalvo$lat, radius = 4, opacity = 1,
        fill = 'black', stroke = TRUE, fillOpacity = 0.75, weight = 2,
        fillColor = "red")
```

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