Modelos de procesos de puntos para el estudio de la visibilidad en los túmulos de As Chans de Barbanza (Galicia)

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# Primera parte “set up”

## Cargar las librerías y establecer el directorio de trabajo

spatpack<-c("raster","spatstat","rgdal","maptools", "MuMIn", "MASS")  
lapply(spatpack, require, character.only=TRUE)

## Loading required package: raster

## Loading required package: sp

## Loading required package: spatstat

## Warning: package 'spatstat' was built under R version 4.0.3

## Loading required package: spatstat.data

## Warning: package 'spatstat.data' was built under R version 4.0.3

## Loading required package: nlme

##   
## Attaching package: 'nlme'

## The following object is masked from 'package:raster':  
##   
## getData

## Loading required package: rpart

##   
## spatstat 1.64-1 (nickname: 'Help you I can, yes!')   
## For an introduction to spatstat, type 'beginner'

##   
## Note: spatstat version 1.64-1 is out of date by more than 11 months; we recommend upgrading to the latest version.

##   
## Attaching package: 'spatstat'

## The following objects are masked from 'package:raster':  
##   
## area, rotate, shift

## Loading required package: rgdal

## Warning: package 'rgdal' was built under R version 4.0.3

## rgdal: version: 1.5-18, (SVN revision 1082)  
## Geospatial Data Abstraction Library extensions to R successfully loaded  
## Loaded GDAL runtime: GDAL 3.0.4, released 2020/01/28  
## Path to GDAL shared files: C:/Users/Usuario/Documents/R/win-library/4.0/rgdal/gdal  
## GDAL binary built with GEOS: TRUE   
## Loaded PROJ runtime: Rel. 6.3.1, February 10th, 2020, [PJ\_VERSION: 631]  
## Path to PROJ shared files: C:/Users/Usuario/Documents/R/win-library/4.0/rgdal/proj  
## Linking to sp version:1.4-4  
## To mute warnings of possible GDAL/OSR exportToProj4() degradation,  
## use options("rgdal\_show\_exportToProj4\_warnings"="none") before loading rgdal.

## Loading required package: maptools

## Warning: package 'maptools' was built under R version 4.0.3

## Checking rgeos availability: TRUE

## Loading required package: MuMIn

## Warning: package 'MuMIn' was built under R version 4.0.4

## Loading required package: MASS

##   
## Attaching package: 'MASS'

## The following object is masked from 'package:spatstat':  
##   
## area

## The following objects are masked from 'package:raster':  
##   
## area, select

## [[1]]  
## [1] TRUE  
##   
## [[2]]  
## [1] TRUE  
##   
## [[3]]  
## [1] TRUE  
##   
## [[4]]  
## [1] TRUE  
##   
## [[5]]  
## [1] TRUE  
##   
## [[6]]  
## [1] TRUE

setwd("C:/Users/Usuario/Desktop/BarbanzaVisualModels") # Directorio de trabajo

## Cargar información de inicio (yacimientos y área de estudio)

tumulos <- read.table(file="csv/yacimientos.csv",header=TRUE, sep=";")  
area\_estudio <- readOGR(dsn="shp/area.shp", layer="area")

## Warning in OGRSpatialRef(dsn, layer, morphFromESRI = morphFromESRI, dumpSRS =  
## dumpSRS, : Discarded datum European\_Terrestrial\_Reference\_System\_1989 in CRS  
## definition: +proj=utm +zone=29 +ellps=GRS80 +towgs84=0,0,0,0,0,0,0 +units=m  
## +no\_defs

## OGR data source with driver: ESRI Shapefile   
## Source: "C:\Users\Usuario\Desktop\BarbanzaVisualModels\shp\area.shp", layer: "area"  
## with 1 features  
## It has 1 fields

# Segunda parte: pasos previos para el análisis de patrón de puntos

## Crear el patrón de puntos de los sitios arqueológicos

area <- as(area\_estudio,"owin")  
sppp <- ppp(x=tumulos$UMTX, y=tumulos$UMTY, window=area)

## Cargar rasters generados con métodos SIG

lcp\_dens <- raster("grids/lcp\_density100m.tiff")

## Warning in showSRID(uprojargs, format = "PROJ", multiline = "NO", prefer\_proj =  
## prefer\_proj): Discarded datum Unknown based on GRS80 ellipsoid in CRS definition

total\_view <- raster("grids/total\_viewshed.tif")

## Warning in showSRID(uprojargs, format = "PROJ", multiline = "NO", prefer\_proj =  
## prefer\_proj): Discarded datum Unknown based on GRS80 ellipsoid in CRS definition

tpi <- raster("grids/TPI.tif")

## Warning in showSRID(uprojargs, format = "PROJ", multiline = "NO", prefer\_proj =  
## prefer\_proj): Discarded datum Unknown based on GRS80 ellipsoid in CRS definition

dist\_ejes\_cuencas <- raster("grids/dist\_cuencas\_hidro.tiff")

## Warning in showSRID(uprojargs, format = "PROJ", multiline = "NO", prefer\_proj =  
## prefer\_proj): Discarded datum Unknown based on GRS80 ellipsoid in CRS definition

total\_horizon <- raster("grids/total\_horizon.tif")

## Warning in showSRID(uprojargs, format = "PROJ", multiline = "NO", prefer\_proj =  
## prefer\_proj): Discarded datum Unknown based on GRS80 ellipsoid in CRS definition

visib\_rutas <- raster("grids/visib\_acum\_desde\_rutas.tiff")

## Warning in showSRID(uprojargs, format = "PROJ", multiline = "NO", prefer\_proj =  
## prefer\_proj): Discarded datum Unknown based on GRS80 ellipsoid in CRS definition

## Convertir las variables a objetos espaciales (para spatstat)

lcp\_densidad <- as.im(as(lcp\_dens, "SpatialGridDataFrame"))  
t\_view <- as.im(as(total\_view,"SpatialGridDataFrame"))  
tprom <- as.im(as(tpi,"SpatialGridDataFrame"))  
d\_ejes\_cuencas <- as.im(as(dist\_ejes\_cuencas,"SpatialGridDataFrame"))  
t\_horizon <- as.im(as(total\_horizon,"SpatialGridDataFrame"))  
visib\_desde\_rutas <- as.im(as(visib\_rutas,"SpatialGridDataFrame"))

# Tercera parte: creación y ejecución del análisis de patrón de puntos

## Modelo 1

(modelo1 = ppm(sppp~lcp\_densidad+t\_view+tprom))

## Nonstationary Poisson process  
##   
## Log intensity: ~lcp\_densidad + t\_view + tprom  
##   
## Fitted trend coefficients:  
## (Intercept) lcp\_densidad t\_view tprom   
## -1.389750e+01 2.618525e-02 8.945376e-08 2.217464e-01   
##   
## Estimate S.E. CI95.lo CI95.hi Ztest  
## (Intercept) -1.389750e+01 3.566937e-01 -1.459661e+01 -1.319839e+01 \*\*\*  
## lcp\_densidad 2.618525e-02 5.196848e-02 -7.567111e-02 1.280416e-01   
## t\_view 8.945376e-08 4.090090e-08 9.289462e-09 1.696181e-07 \*  
## tprom 2.217464e-01 2.459185e-01 -2.602451e-01 7.037379e-01   
## Zval  
## (Intercept) -38.9620059  
## lcp\_densidad 0.5038679  
## t\_view 2.1870852  
## tprom 0.9017068

## Modelo 2

(modelo2 = ppm(sppp~d\_ejes\_cuencas+t\_horizon+visib\_desde\_rutas))

## Nonstationary Poisson process  
##   
## Log intensity: ~d\_ejes\_cuencas + t\_horizon + visib\_desde\_rutas  
##   
## Fitted trend coefficients:  
## (Intercept) d\_ejes\_cuencas t\_horizon visib\_desde\_rutas   
## -1.180705e+01 -2.520354e-02 3.029313e-05 -8.611419e-05   
##   
## Estimate S.E. CI95.lo CI95.hi Ztest  
## (Intercept) -1.180705e+01 3.819420e-01 -1.255564e+01 -1.105845e+01 \*\*\*  
## d\_ejes\_cuencas -2.520354e-02 6.173410e-03 -3.730320e-02 -1.310388e-02 \*\*\*  
## t\_horizon 3.029313e-05 7.408012e-06 1.577369e-05 4.481256e-05 \*\*\*  
## visib\_desde\_rutas -8.611419e-05 3.818737e-04 -8.345729e-04 6.623445e-04   
## Zval  
## (Intercept) -30.9131972  
## d\_ejes\_cuencas -4.0825955  
## t\_horizon 4.0892382  
## visib\_desde\_rutas -0.2255044

## Modelo 3

(modelo3 = ppm(sppp~1)) # Modelo nulo

## Stationary Poisson process  
## Intensity: 1.736378e-06  
## Estimate S.E. CI95.lo CI95.hi Ztest Zval  
## log(lambda) -13.26371 0.1856953 -13.62767 -12.89975 \*\*\* -71.42726

## Comparar los AIC’s para los modelos

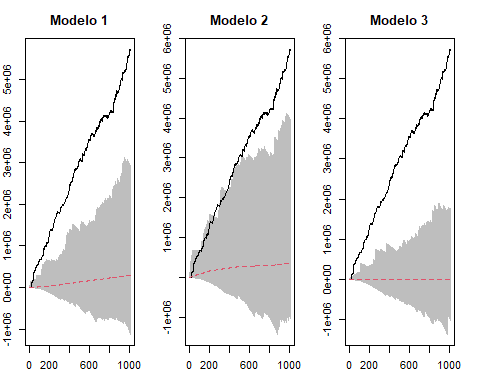
Modelo | AIC  
-------------------------------|--------------  
Modelo 1 | 827.1675454  
Modelo 2 | 766.2437141  
Modelo 3 | 829.2951307

## Calcular las K residuales

residualK\_mod1 = envelope(modelo1,Kres,correction="all",nsim=999)  
residualK\_mod2 = envelope(modelo2,Kres,correction="all",nsim=999)  
residualK\_mod3 = envelope(modelo3,Kres,correction="all",nsim=999)

## Generar un gráfico de las funciones K residuales de los modelos

par(mar=c(3, 2, 3, 2), mfrow=c(1,3))  
plot(residualK\_mod1, legend = F, main="Modelo 1")  
plot(residualK\_mod2, legend = F,main="Modelo 2")  
plot(residualK\_mod3, legend = F,main="Modelo 3")



par(mfrow=c(1,1))