GWR Tower Hamlets

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08/11/2019

```
Census.Data <-read.csv("~/Documents/r
programming/data/practical_data_Tower_Hamlets.csv")

# load the spatial libraries
library("sp")
library("rgdal")
```

```
## rgdal: version: 1.4-7, (SVN revision 845)
##  Geospatial Data Abstraction Library extensions to R successfully loaded
##  Loaded GDAL runtime: GDAL 2.4.2, released 2019/06/28
##  Path to GDAL shared files:
/Library/Frameworks/R.framework/Versions/3.6/Resources/library/rgdal/gdal
##  GDAL binary built with GEOS: FALSE
##  Loaded PROJ.4 runtime: Rel. 5.2.0, September 15th, 2018, [PJ_VERSION:
520]
##  Path to PROJ.4 shared files:
/Library/Frameworks/R.framework/Versions/3.6/Resources/library/rgdal/proj
##  Linking to sp version: 1.3-1
```

```
library("rgeos")
```

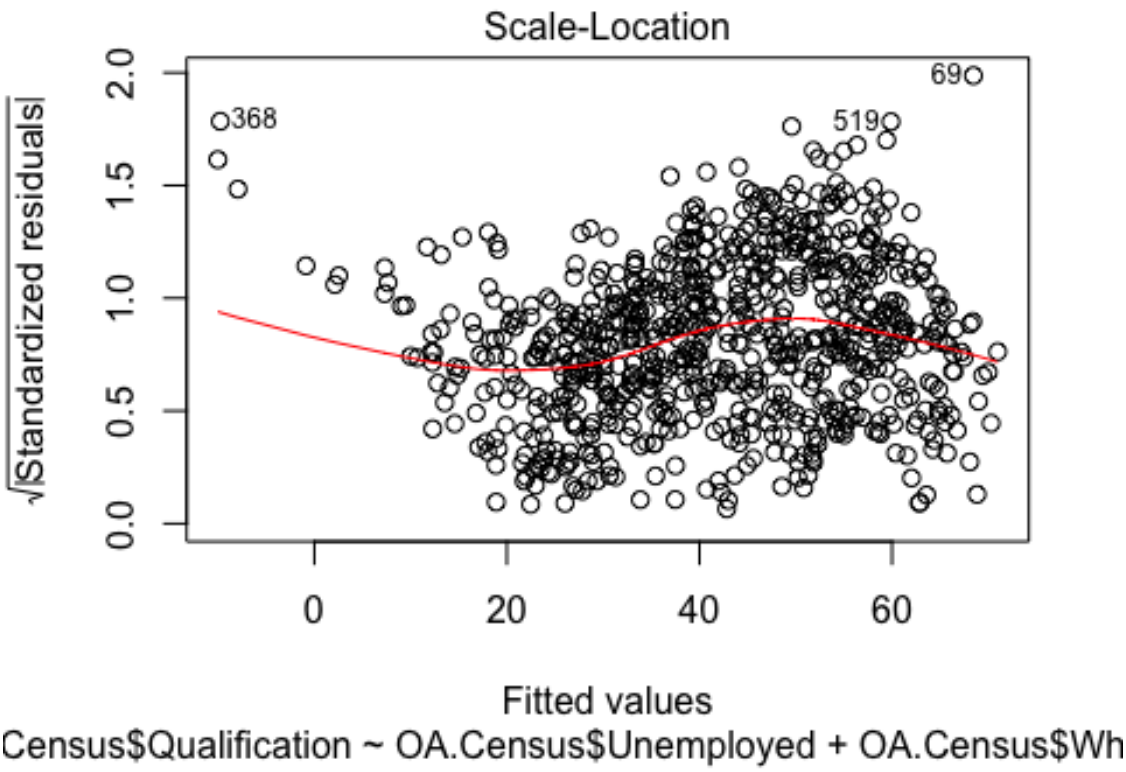
```
## rgeos version: 0.5-2, (SVN revision 621)
##  GEOS runtime version: 3.7.2-CAPI-1.11.2
##  Linking to sp version: 1.3-1
##  Polygon checking: TRUE
```

```
library("tmap")

# Load the output area shapefiles
Output.Areas <- readOGR("~/Documents/r programming/th data/th shapefile",
"Tower_Hamlets_oa11")
```

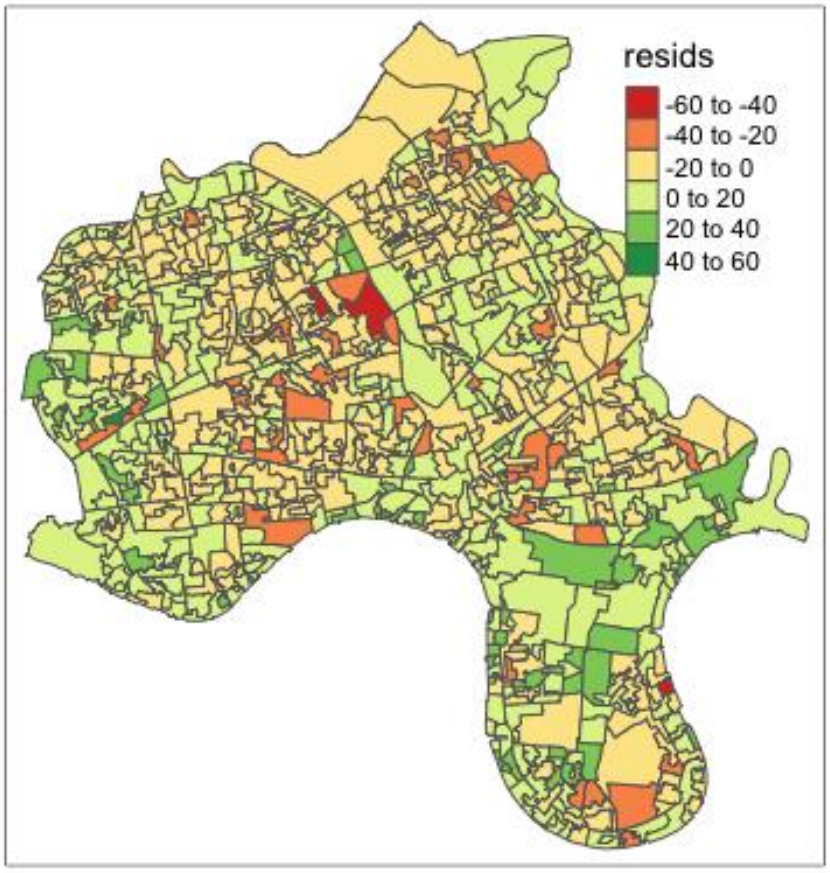
```
## OGR data source with driver: ESRI Shapefile
## Source: "/Users/maishachowdhury/Documents/r programming/th data/th
shapefile", layer: "Tower_Hamlets_oa11"
## with 748 features
## It has 1 fields
```

```
OA.Census <- merge(Output.Areas, Census.Data, by.x="OA11CD", by.y="OA")

#run a linear model
# runs a linear model
model <- lm(OA.Census$Qualification ~
```

```
OA.Census$Unemployed+OA.Census$White_British)

summary(model)

##
## Call:
## lm(formula = OA.Census$Qualification ~ OA.Census$Unemployed +
##     OA.Census$White_British)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -52.253  -8.465  -0.475   9.117  41.737
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)              60.37948    2.19093  27.559  < 2e-16 ***
## OA.Census$Unemployed    -3.87469    0.17481 -22.165  < 2e-16 ***
## OA.Census$White_British  0.22745    0.03854   5.902 5.46e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.28 on 745 degrees of freedom
## Multiple R-squared:  0.5523, Adjusted R-squared:  0.5511
## F-statistic: 459.6 on 2 and 745 DF,  p-value: < 2.2e-16

plot(model, which = 3)
```




```
#mapping the residuals
resids<-residuals(model)

map.resids<-OA.Census

map.resids@data <- cbind(OA.Census@data, resids)

# we need to rename the column header from the resids file - in this case its
the 6th column of map.resids
names(map.resids)[6] <- "resids"

# maps the residuals using the quickmap function from tmap
qtm(map.resids, fill = "resids")

## Variable "resids" contains positive and negative values, so midpoint is
set to 0. Set midpoint = NA to show the full spectrum of the color palette.
```



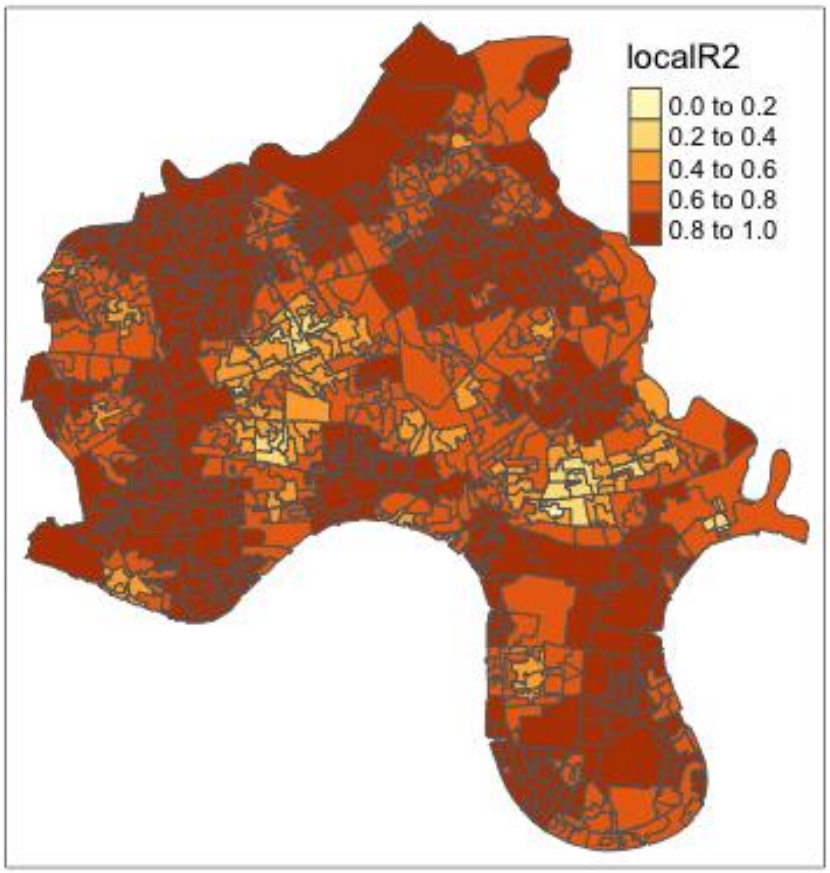

```
#kernel bandwidth

library("spgwr")

## Loading required package: spData

## To access larger datasets in this package, install the spDataLarge
## package with: `install.packages('spDataLarge',
## repos='https://nowosad.github.io/drat/', type='source')`

## NOTE: This package does not constitute approval of GWR
## as a method of spatial analysis; see example(gwr)

#calculate kernel bandwidth
GWRbandwidth <- gwr.sel(OA.Census$Qualification ~
OA.Census$Unemployed+OA.Census$White_British, data=OA.Census,adapt=T)

## Adaptive q: 0.381966 CV score: 116623.8
## Adaptive q: 0.618034 CV score: 122518.5
## Adaptive q: 0.236068 CV score: 110649.5
## Adaptive q: 0.145898 CV score: 104426.9
## Adaptive q: 0.09016994 CV score: 98078.97
## Adaptive q: 0.05572809 CV score: 93840.1
## Adaptive q: 0.03444185 CV score: 90494.83
```

```
## Adaptive q: 0.02128624 CV score: 87722.73
## Adaptive q: 0.01315562 CV score: 84960.05
## Adaptive q: 0.008130619 CV score: 82459.67
## Adaptive q: 0.005024999 CV score: 81315.07
## Adaptive q: 0.00310562 CV score: 85607.29
## Adaptive q: 0.00621124 CV score: 81723.71
## Adaptive q: 0.004291861 CV score: 81540.09
## Adaptive q: 0.005110608 CV score: 81316.68
## Adaptive q: 0.004984309 CV score: 81315.5
## Adaptive q: 0.005065689 CV score: 81315.42
## Adaptive q: 0.005024999 CV score: 81315.07
```

```
#run the gwr model
gwr.model = gwr(OA.Census$Qualification ~
OA.Census$Unemployed+OA.Census$White_British, data = OA.Census,
adapt=GWRbandwidth, hatmatrix=TRUE, se.fit=TRUE)

#print the results of the model
gwr.model
```

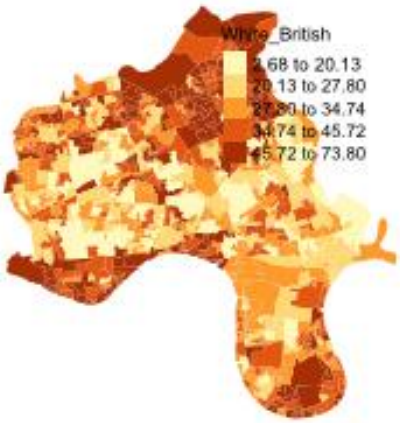
```
## Call:
## gwr(formula = OA.Census$Qualification ~ OA.Census$Unemployed +
##     OA.Census$White_British, data = OA.Census, adapt = GWRbandwidth,
##     hatmatrix = TRUE, se.fit = TRUE)
## Kernel function: gwr.Gauss
## Adaptive quantile: 0.005024999 (about 3 of 748 data points)
## Summary of GWR coefficient estimates at data points:
##                               Min.   1st Qu.    Median   3rd Qu.      Max.
## X.Intercept.             -40.23985  26.48390  40.33594  60.92955 136.62437
## OA.Census.Unemployed      -8.03468  -4.13438  -2.36091  -1.33547   1.67598
## OA.Census.White_British   -1.35035   0.15539   0.43264   0.72545   1.90583
##                           Global
## X.Intercept.             60.3795
## OA.Census.Unemployed     -3.8747
## OA.Census.White_British   0.2275
## Number of data points: 748
## Effective number of parameters (residual: 2traceS - traceS'S): 303.3372
## Effective degrees of freedom (residual: 2traceS - traceS'S): 444.6628
## Sigma (residual: 2traceS - traceS'S): 9.417848
## Effective number of parameters (model: traceS): 224.4378
## Effective degrees of freedom (model: traceS): 523.5622
## Sigma (model: traceS): 8.679265
## Sigma (ML): 7.261332
## AICc (GWR p. 61, eq 2.33; p. 96, eq. 4.21): 5735.271
## AIC (GWR p. 96, eq. 4.22): 5313.084
## Residual sum of squares: 39439.75
## Quasi-global R2: 0.8656679
```

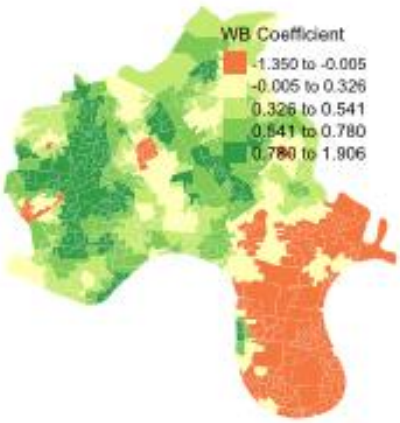
```
results <-as.data.frame(gwr.model$SDF)

names(results)

##  [1] "sum.w"                          "X.Intercept."
##  [3] "OA.Census.Unemployed"           "OA.Census.White_British"
##  [5] "X.Intercept._se"                "OA.Census.Unemployed_se"
##  [7] "OA.Census.White_British_se"     "gwr.e"
##  [9] "pred"                           "pred.se"
## [11] "localR2"                        "X.Intercept._se_EDF"
## [13] "OA.Census.Unemployed_se_EDF"    "OA.Census.White_British_se_EDF"
## [15] "pred.se.1"

gwr.map<- OA.Census

gwr.map@data <- cbind(OA.Census@data, as.matrix(results))

qtm(gwr.map, fill = "localR2")
```



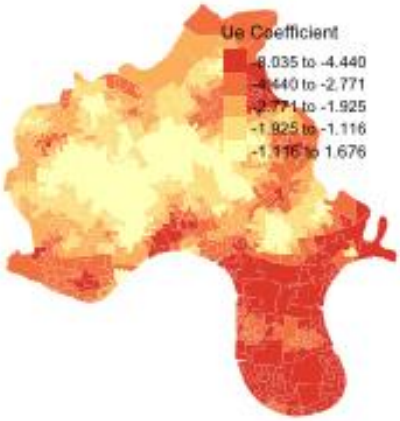

```
#using grid extra

# create tmap objects
map1 <- tm_shape(gwr.map) + tm_fill("White_British", n = 5, style =
```

```
"quantile")  + tm_layout(frame = FALSE, legend.text.size = 0.5,
legend.title.size = 0.6)
map2 <- tm_shape(gwr.map) + tm_fill("OA.Census.White_British", n = 5, style =
"quantile", title = "WB Coefficient") + tm_layout(frame = FALSE,
legend.text.size = 0.5, legend.title.size = 0.6)
map3 <- tm_shape(gwr.map) + tm_fill("Unemployed", n = 5, style = "quantile")
+ tm_layout(frame = FALSE, legend.text.size = 0.5, legend.title.size = 0.6)
map4 <- tm_shape(gwr.map) + tm_fill("OA.Census.Unemployed", n = 5, style =
"quantile", title = "Ue Coefficient") + tm_layout(frame = FALSE,
legend.text.size = 0.5, legend.title.size = 0.6)

library(grid)
library(gridExtra)
# creates a clear grid
grid.newpage()
# assigns the cell size of the grid, in this case 2 by 2
pushViewport(viewport(layout=grid.layout(2,2)))

# prints a map object into a defined cell
print(map1, vp=viewport(layout.pos.col = 1, layout.pos.row =1))
print(map2, vp=viewport(layout.pos.col = 2, layout.pos.row =1))

## Variable "OA.Census.White_British" contains positive and negative values,
so midpoint is set to 0. Set midpoint = NA to show the full spectrum of the
color palette.

## Some legend labels were too wide. These labels have been resized to 0.43,
0.45. Increase legend.width (argument of tm_layout) to make the legend wider
and therefore the labels larger.

#> Variable "OA.Census.White_British" contains positive and negative values,
so midpoint is set to 0. Set midpoint = NA to show the full spectrum of the
color palette.
print(map3, vp=viewport(layout.pos.col = 1, layout.pos.row =2))
print(map4, vp=viewport(layout.pos.col = 2, layout.pos.row =2))

## Variable "OA.Census.Unemployed" contains positive and negative values, so
midpoint is set to 0. Set midpoint = NA to show the full spectrum of the
color palette.

## Legend labels were too wide. The labels have been resized to 0.43, 0.43,
0.43, 0.43, 0.45. Increase legend.width (argument of tm_layout) to make the
legend wider and therefore the labels larger.
```


White_British
2.68 to 20.13
20.13 to 27.80
27.80 to 34.74
34.74 to 45.72
45.72 to 73.80


WB Coefficient
-1.350 to -0.005
-0.005 to 0.326
0.326 to 0.541
0.541 to 0.780
0.780 to 1.906


Unemployed
0.00 to 3.70
3.70 to 5.53
5.53 to 7.48
7.48 to 9.64
9.64 to 19.58


Ue Coefficient
-8.035 to -4.440
-4.440 to -2.771
-2.771 to -1.925
-1.925 to -1.116
-1.116 to 1.676