SPATIAL STATISTICS IN R

Areal statistics

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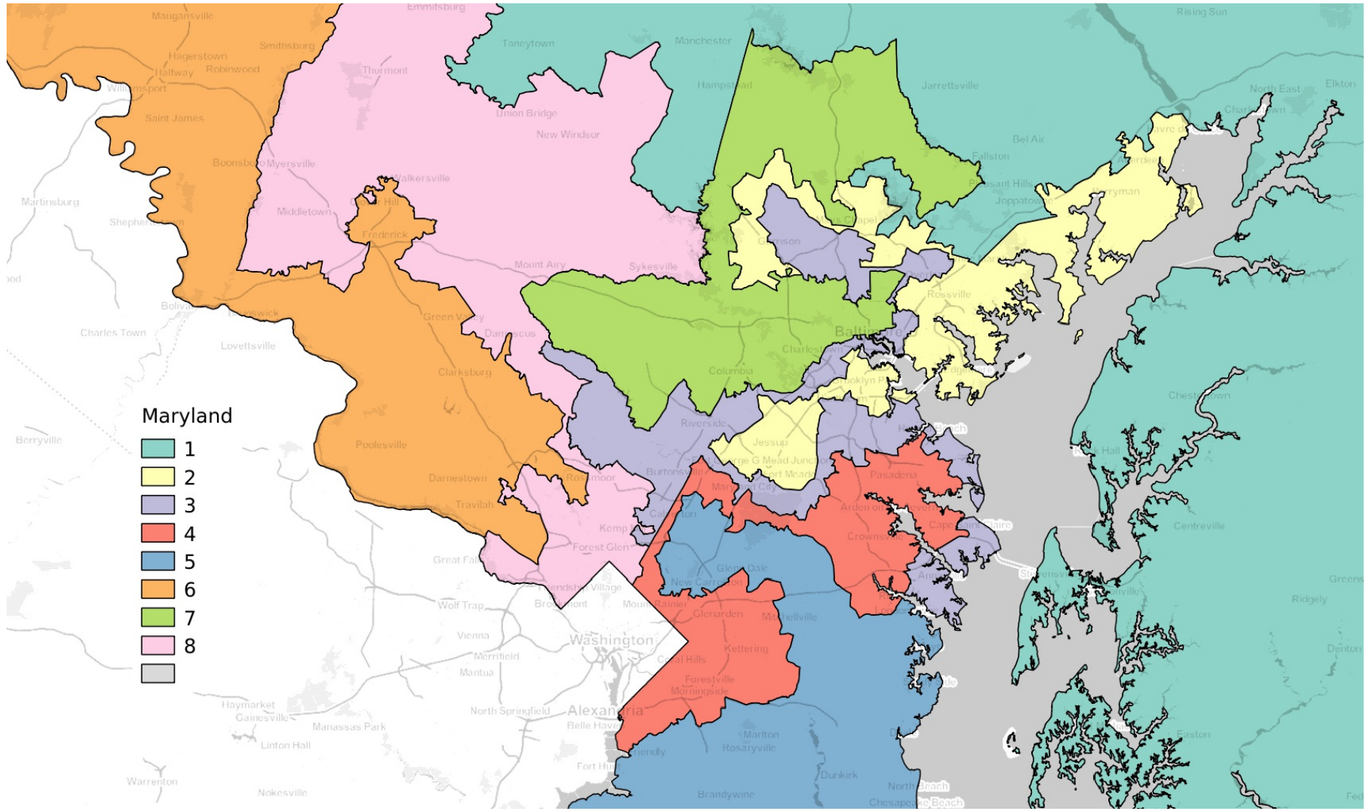
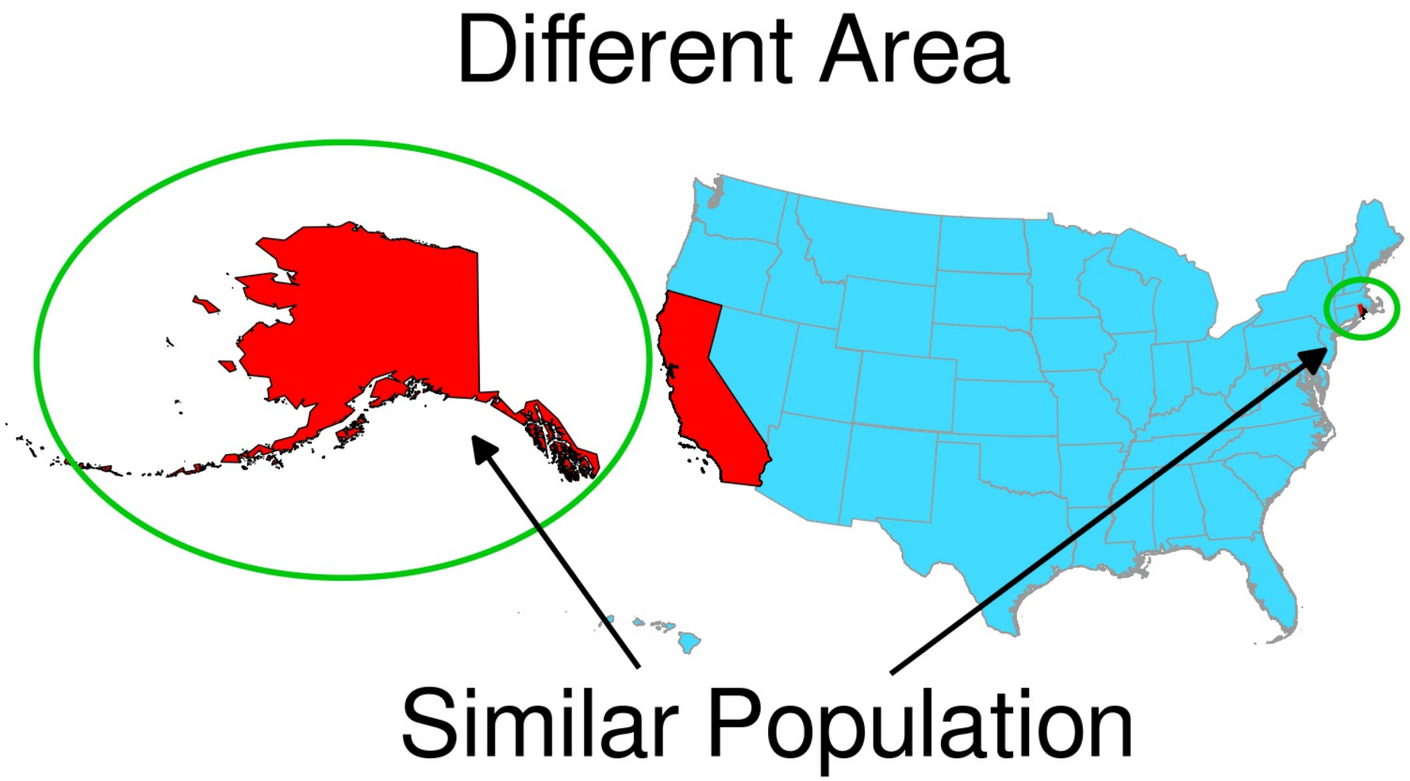
Borders


USA
Mexico
Lewis Airport
Bertani Ranch Airport
Del Rio International Airport
Laughlin Air Force Base
Del Rio
Ciudad Acuña New International Airport
Ciudad Acuña
Fort Clark Springs Airport
La Fonda Ranch Airport
Spofford Airport
Dunbar Ranch Airport
Hughes Ranch Airport
San Carlos

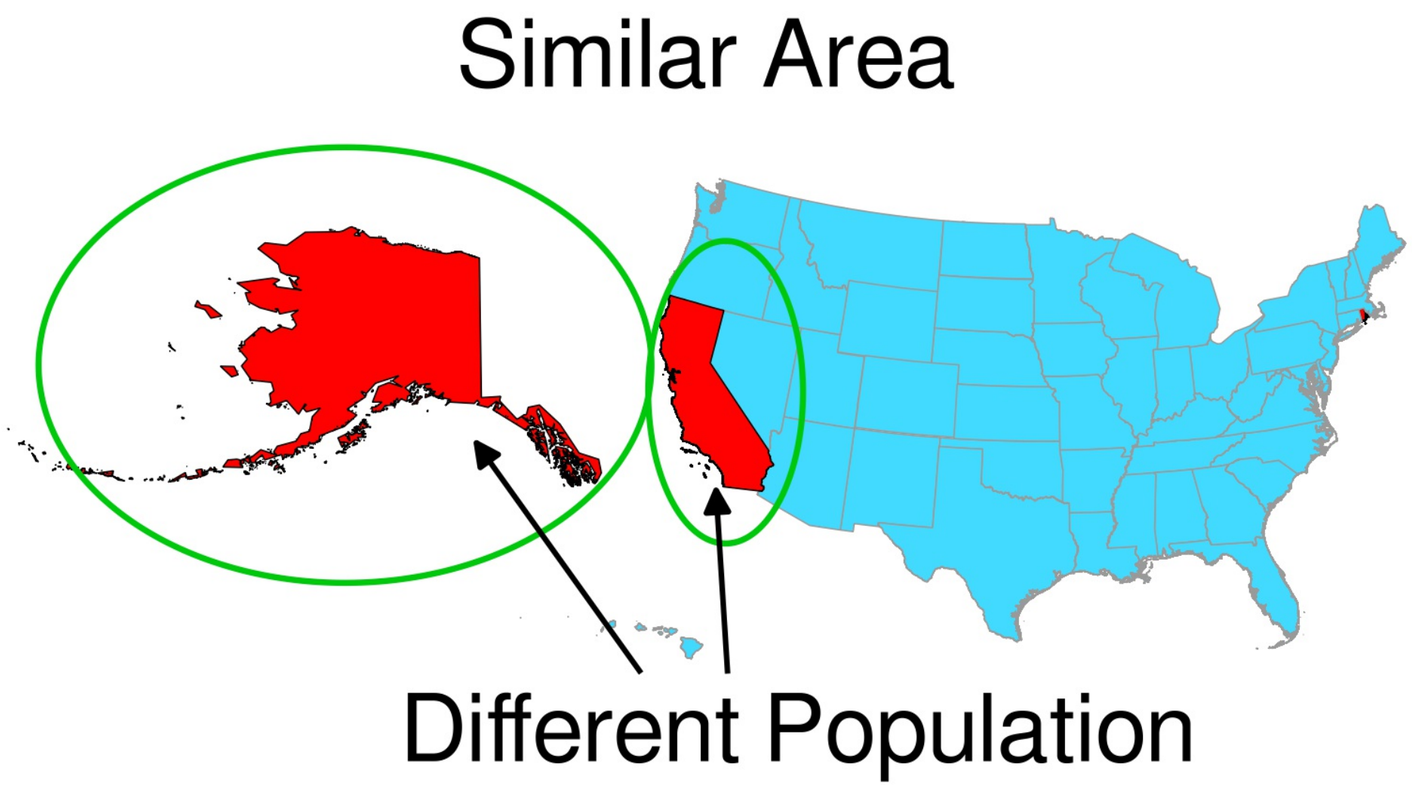
US Congressional Borders



Similar Population



Similar Area

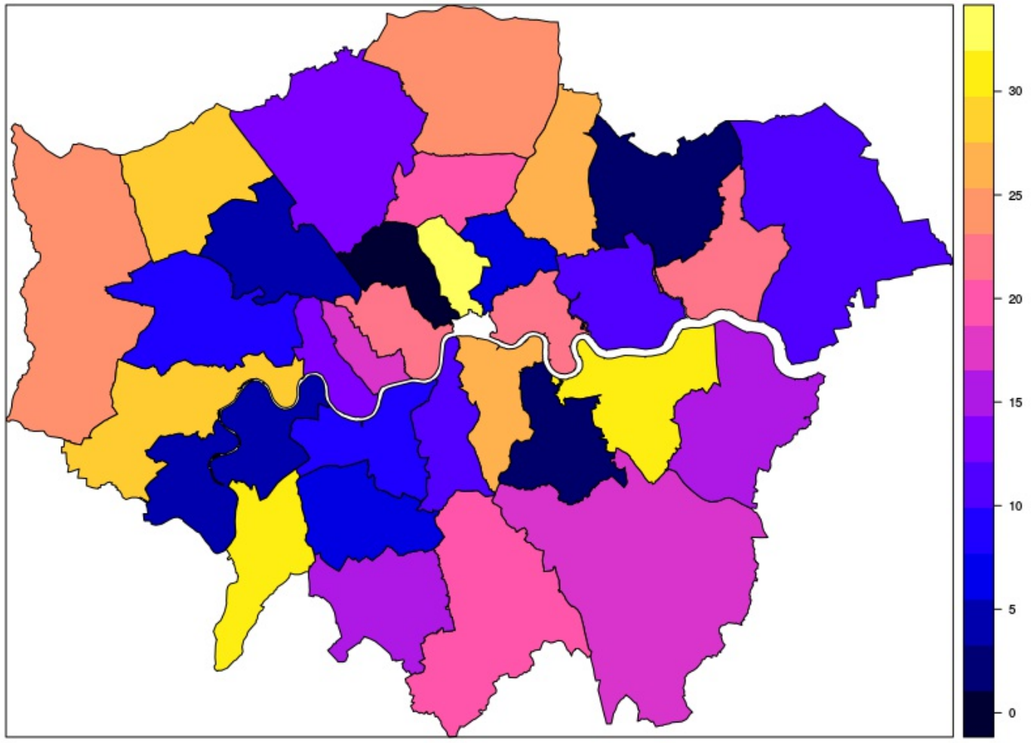


Cartogram

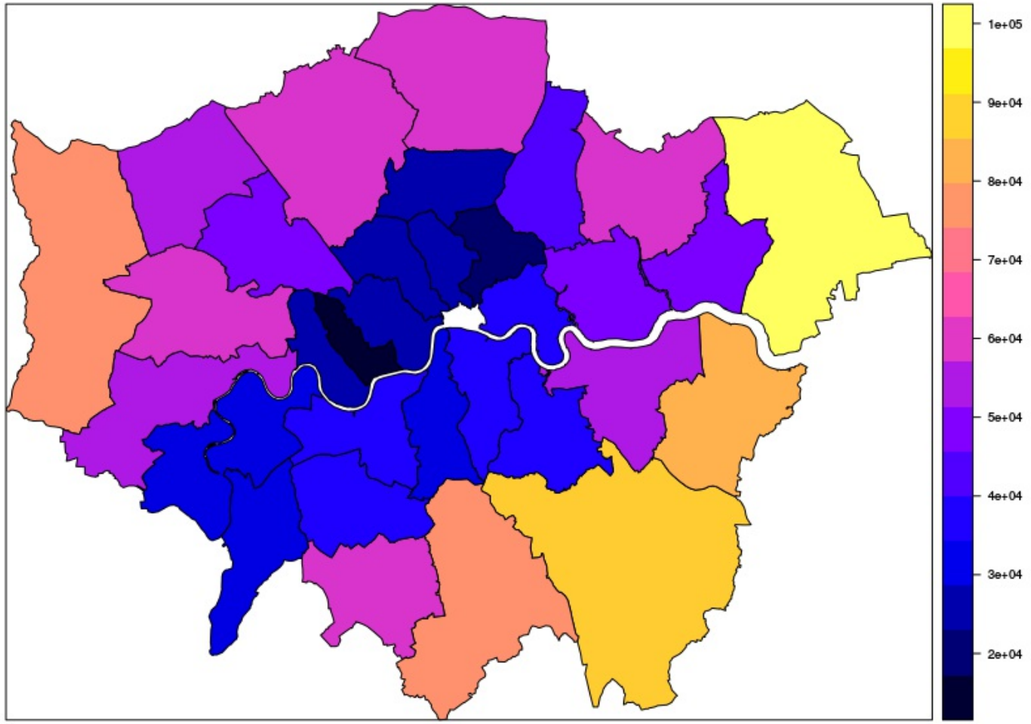
Africa Map

Population Cartogram

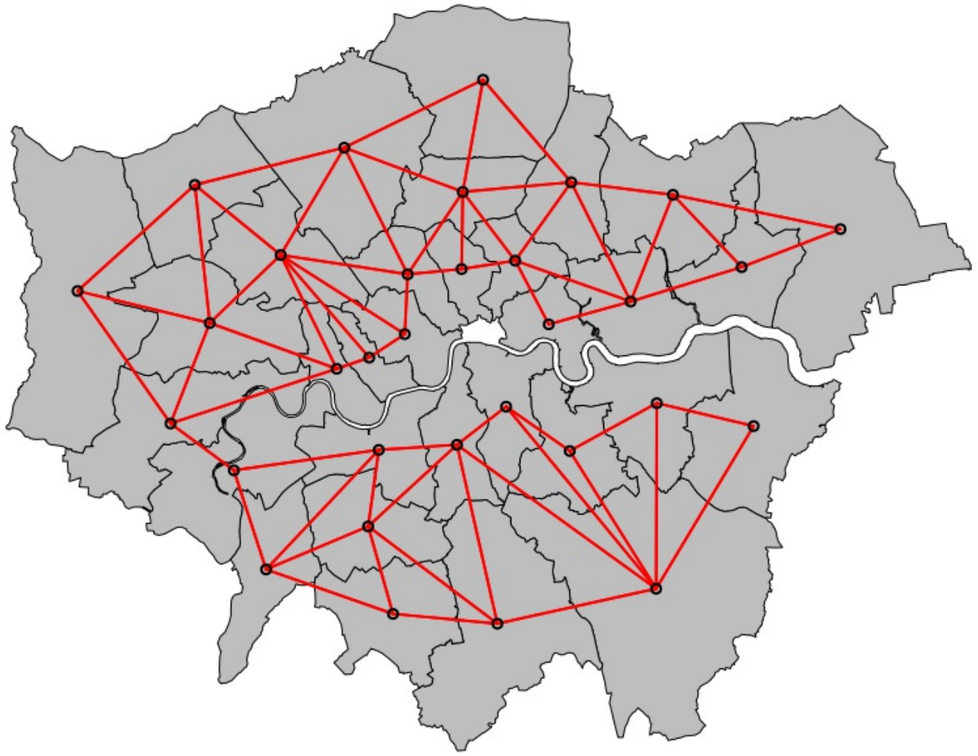
Spatially Random



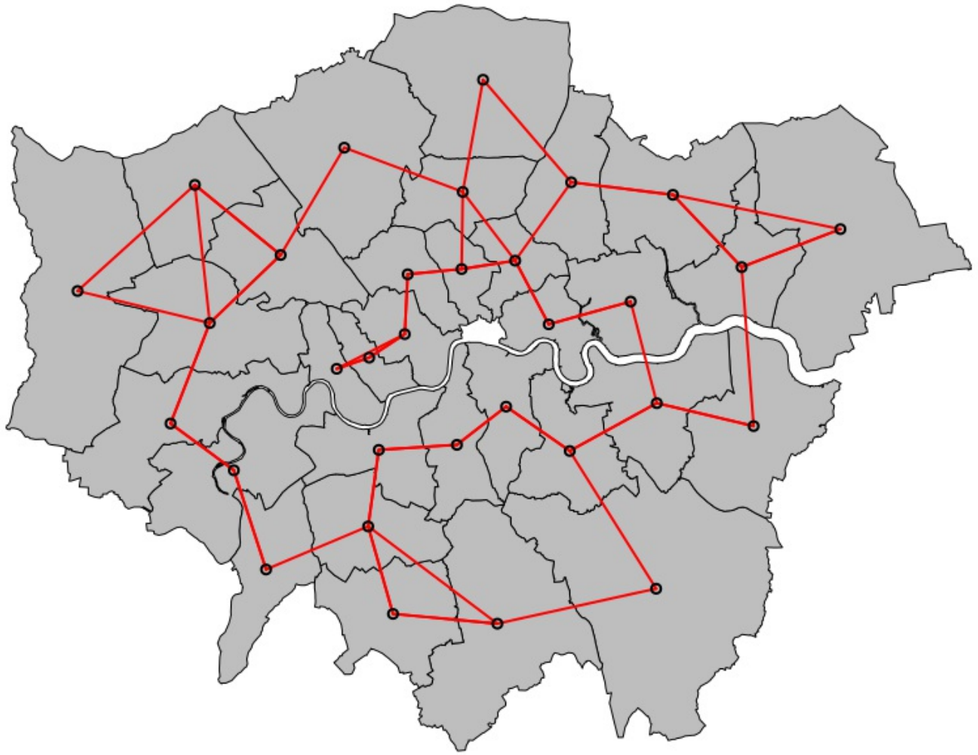
Spatial Structure



Adjacent



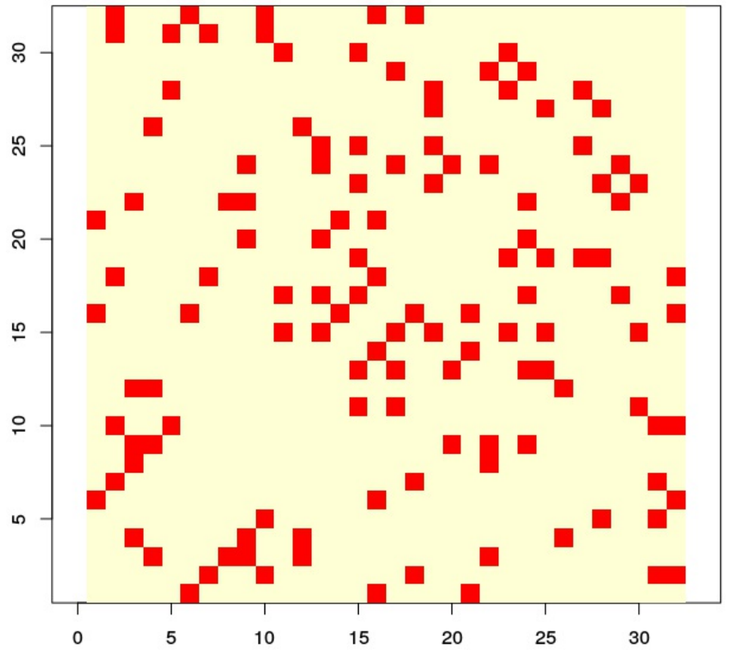
Nearest



Adjacency Representations

```
[[1]]
[1]  6 16 21

[[2]]
[1]  7 10 18 31 32

[[3]]
[1]  4  8  9 12 22

[[4]]
[1]  3  9 12 26

[[5]]
[1] 10 28 31

[[6]]
[1]  1 16 32
...
```

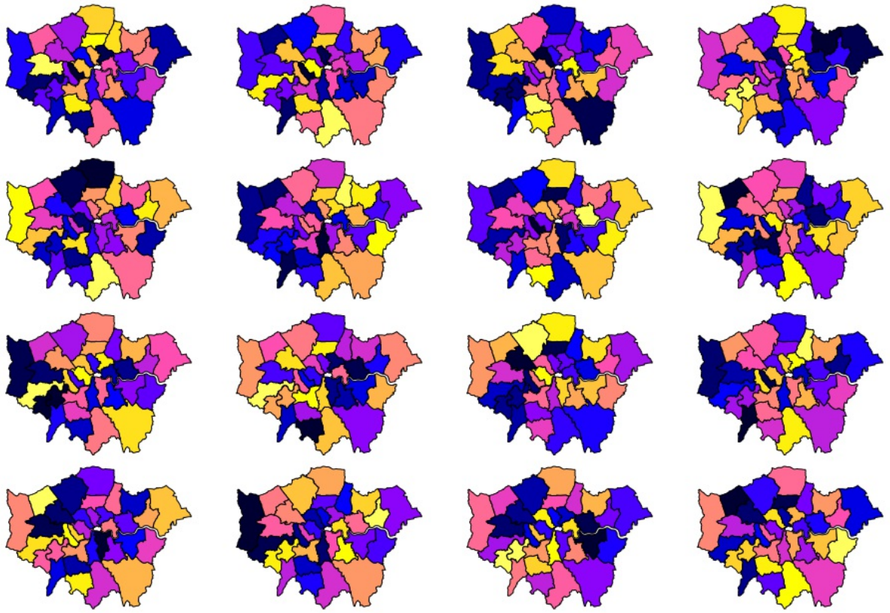
```
  [,1] [,2] [,3] [,4] [,5] [,6]
0    0    0    0    0    0    1
1    0    0    0    0    0    0
2    0    0    0    1    0    0
3    0    0    1    0    0    0
```

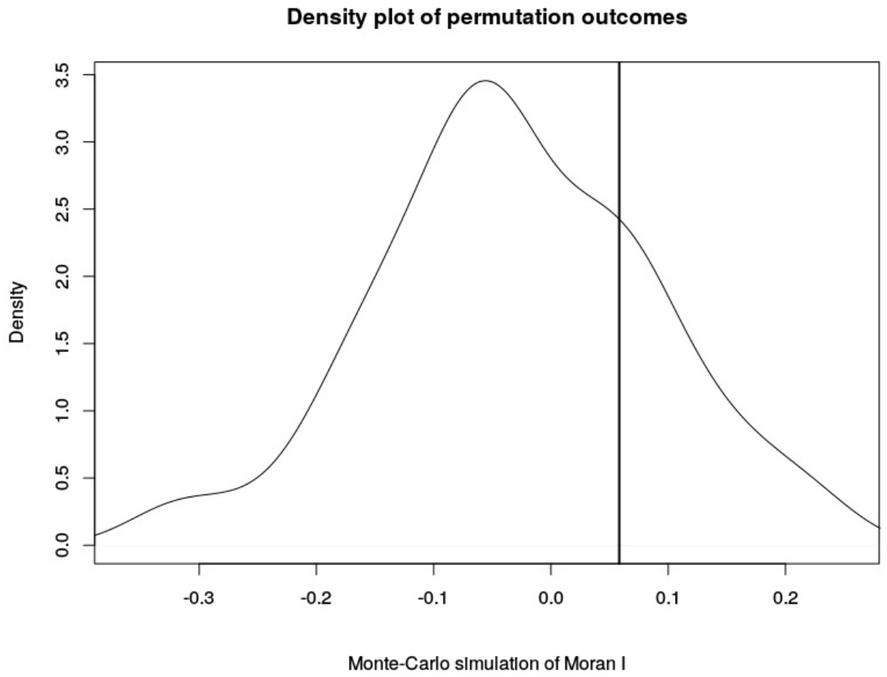


Moran I

$$I = \frac{n}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(z_i - \bar{z})(z_j - \bar{z})}{\sum_i (z_i - \bar{z})^2}$$

Moran I Test




Density plot of permutation outcomes
Density
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
-0.3
-0.2
-0.1
0.0
0.1
0.2
Monte-Carlo simulation of Moran I

SPATIAL STATISTICS IN R

Let's practice!

SPATIAL STATISTICS IN R

Spatial health data

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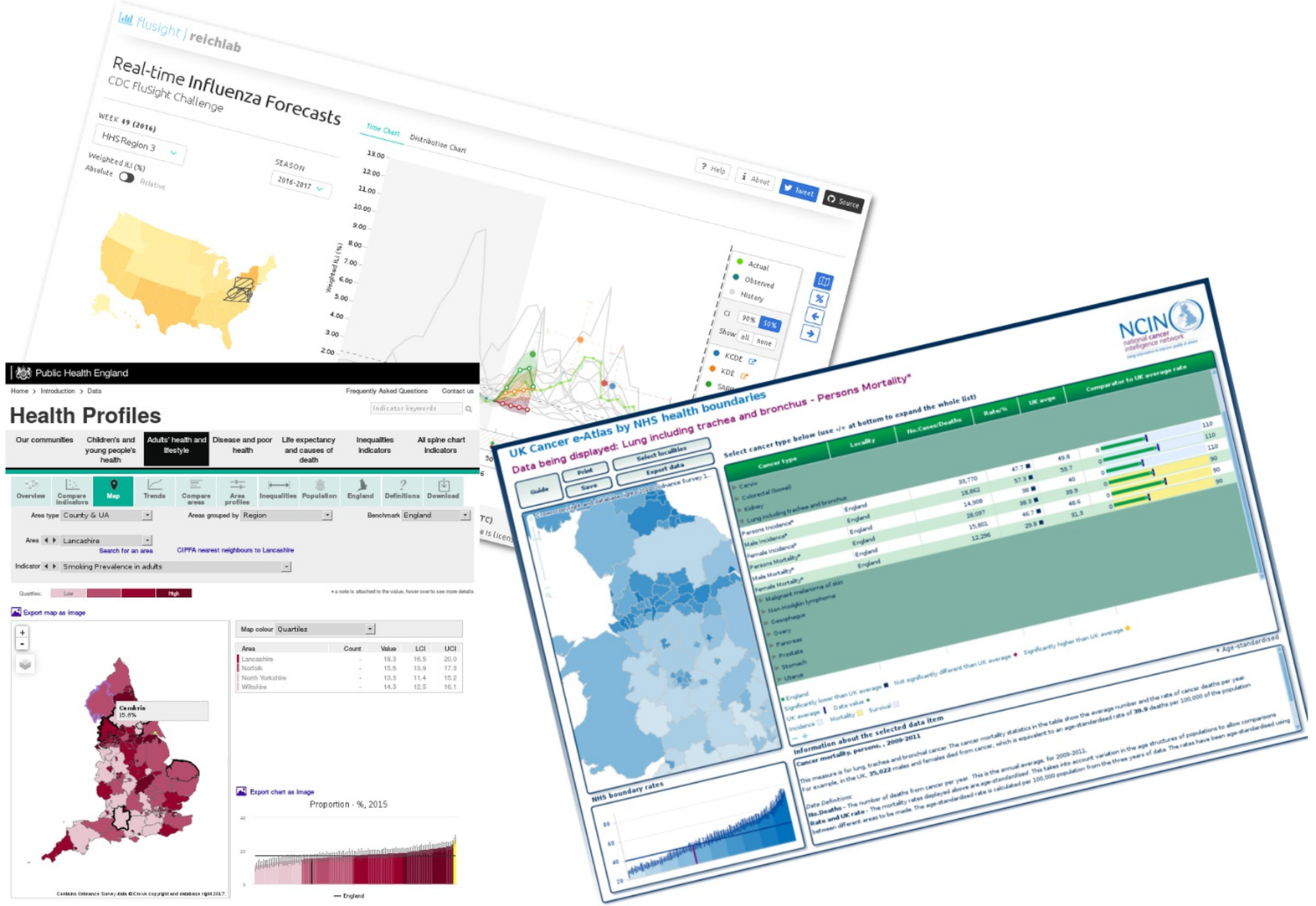
Spatially Healthy


Flusight | reichlab
Real-time Influenza Forecasts
CDC FluSight Challenge
Public Health England
Health Profiles
UK Cancer e-Atlas by NHS health boundaries
Data being displayed: Lung including trachea and bronchus - Persons Mortality*
NCIN
national cancer intelligence network

Incidence Rate

$$R_i = \frac{N_i}{P_i}$$

$$\text{Rate } \mathbf{is} \frac{\text{Number of Cases}}{\text{Population At Risk}}$$

Standardized Morbidity Ratio

$$\text{SMR in region } i = \frac{R_i}{\text{Overall Rate}}$$

Overall Rate

$$\mathbf{R} = \frac{\sum N_i}{\sum P_i}$$

$$\text{Overall Rate } \mathbf{is} \frac{\text{Total Cases}}{\text{Total Population}}$$

Expected Cases

$$E_i = \mathbf{R} \times P_i$$

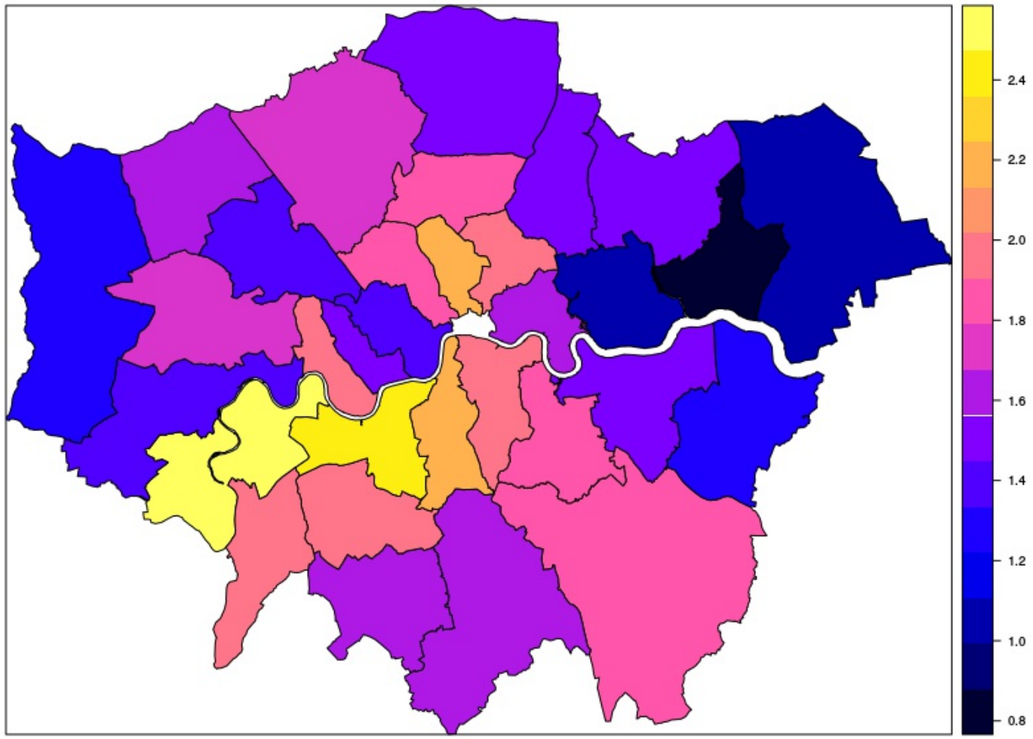
Expected Cases **is** Overall Rate $\times$ Population

Standardized Morbidity Ratio

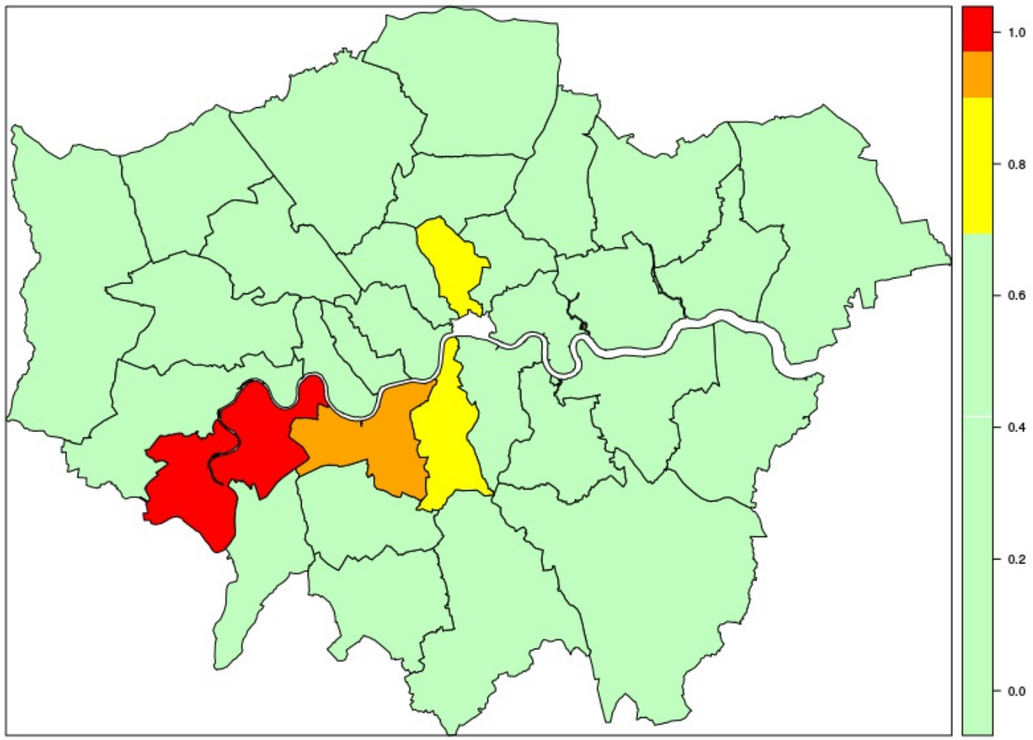
$$\text{SMR}_i = \frac{N_i}{E_i}$$

$$\text{Std Morbidity Rate } \textbf{is } \frac{\text{No. of Cases}}{\text{Expected}}$$

SMR Map



Exceedence Probability Map



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SPATIAL STATISTICS IN R

Generalized linear models in space

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Generally Linear

Linear Model

$$Y \sim \mathrm{N}(X\beta, \sigma^2)$$

Generalized Linear Model

$$Y \sim \mathrm{D}(\mu(X\beta))$$

Poisson (Count) GLM

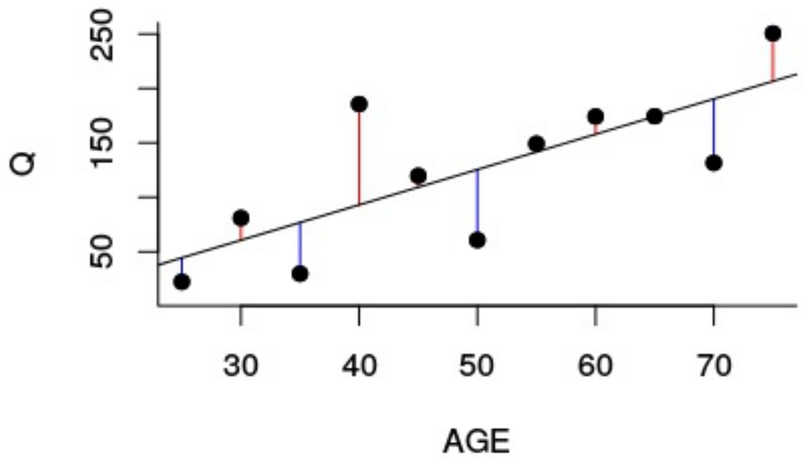
$$Y \sim \text{Poisson}(e^{X\beta})$$

Parameter Estimation

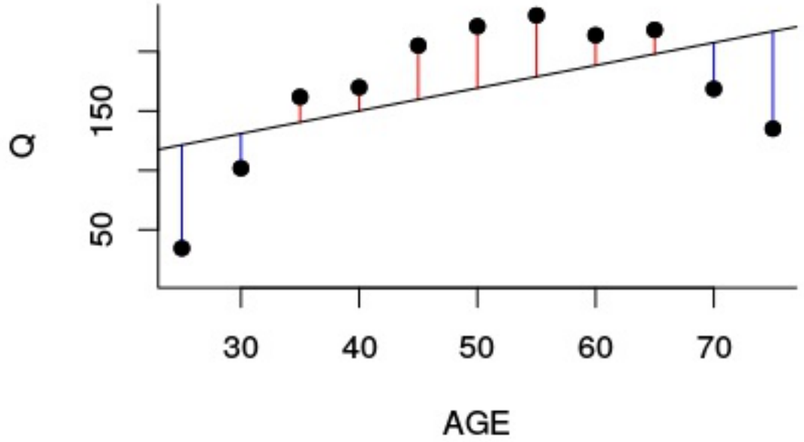
```
> summary(fit)
```

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	24.28	25.44	0.95	0.3448	
AGE	1.69	0.53	3.16	0.0028	**
SHOESIZE	0.17	1.61	0.11	0.9155	

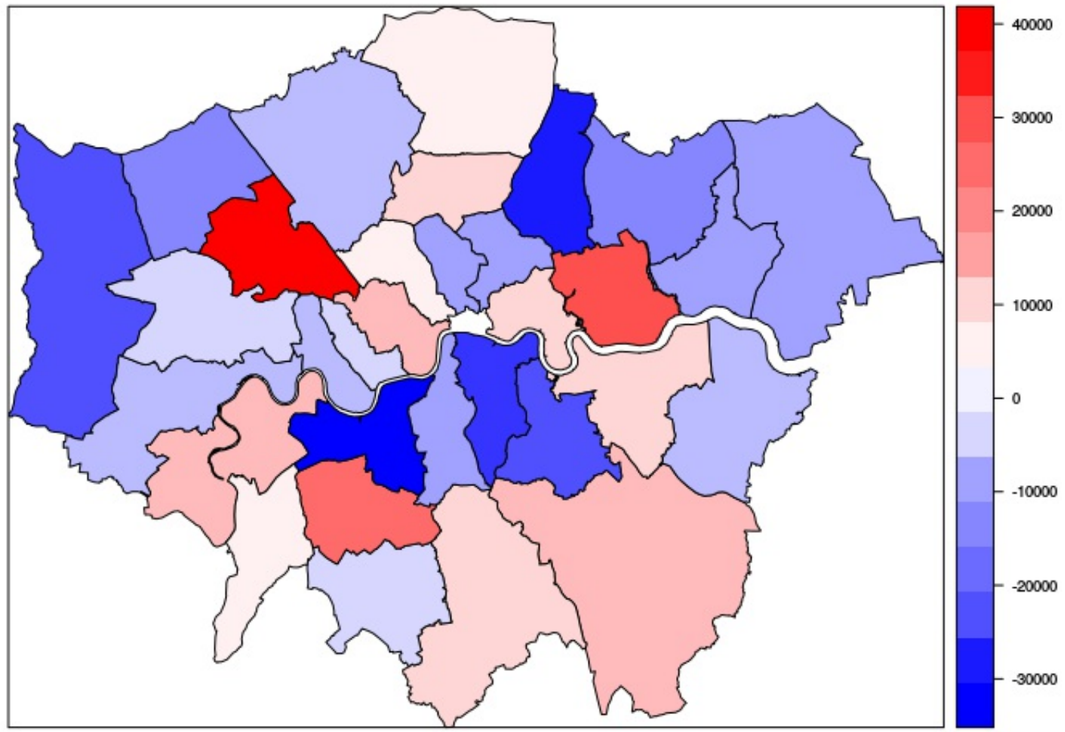
Fit



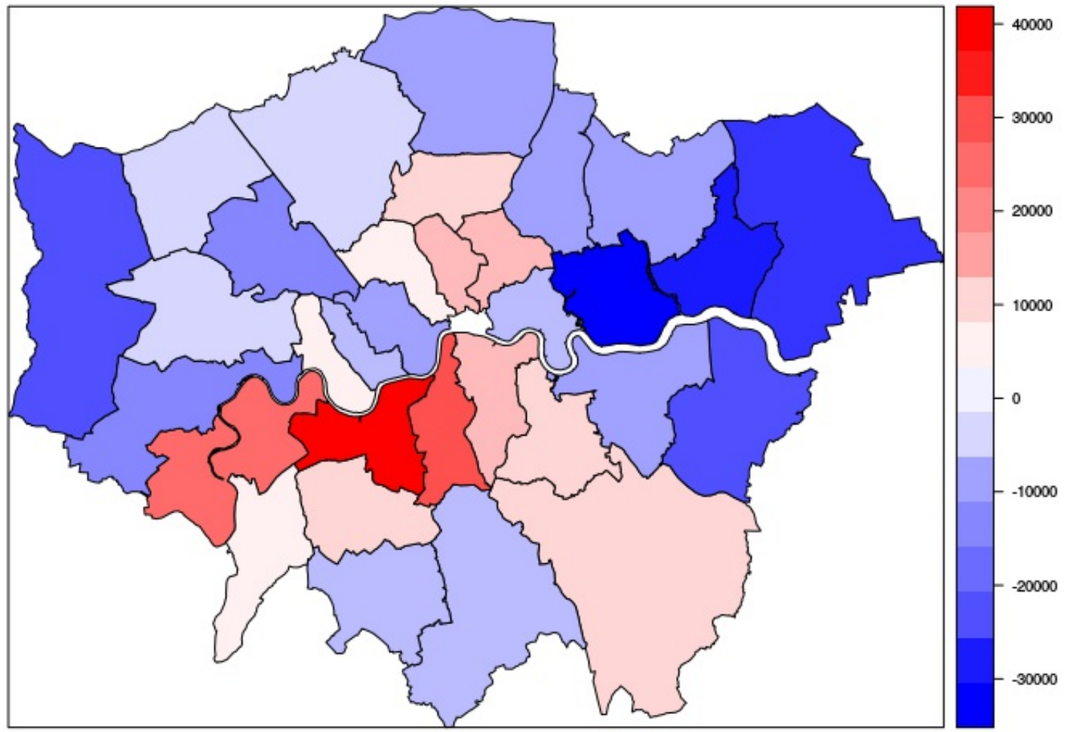
Misfit



Random Residuals



Spatially Structured Residuals



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Correlation in spatial GLMs

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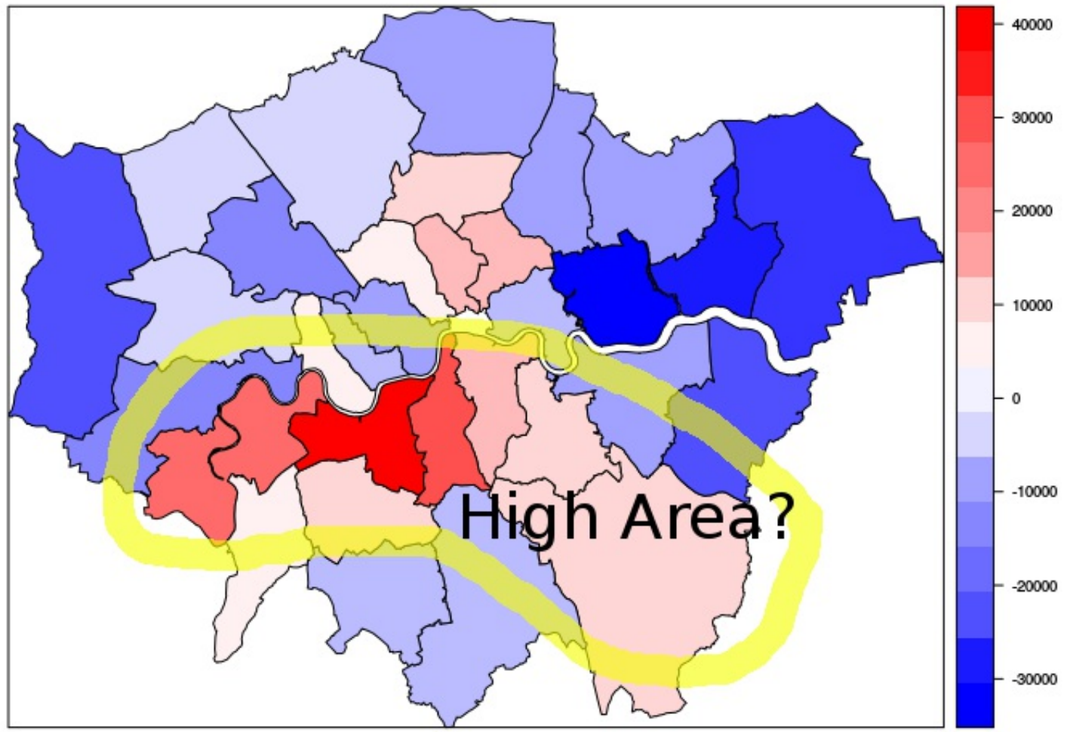
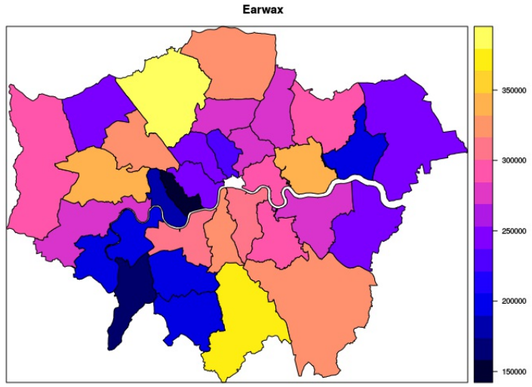
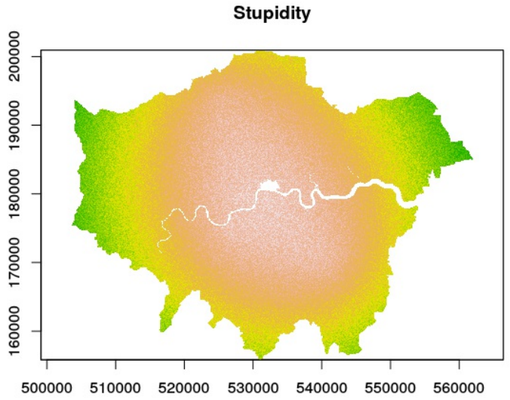
Spatially Correlated

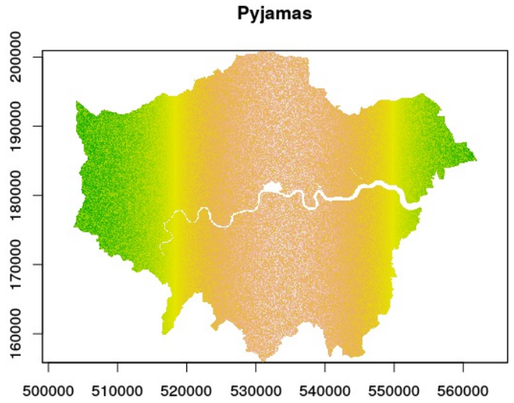
Correlated Residuals

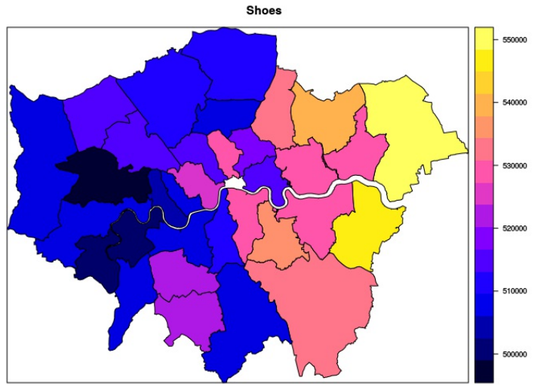


New Covariates





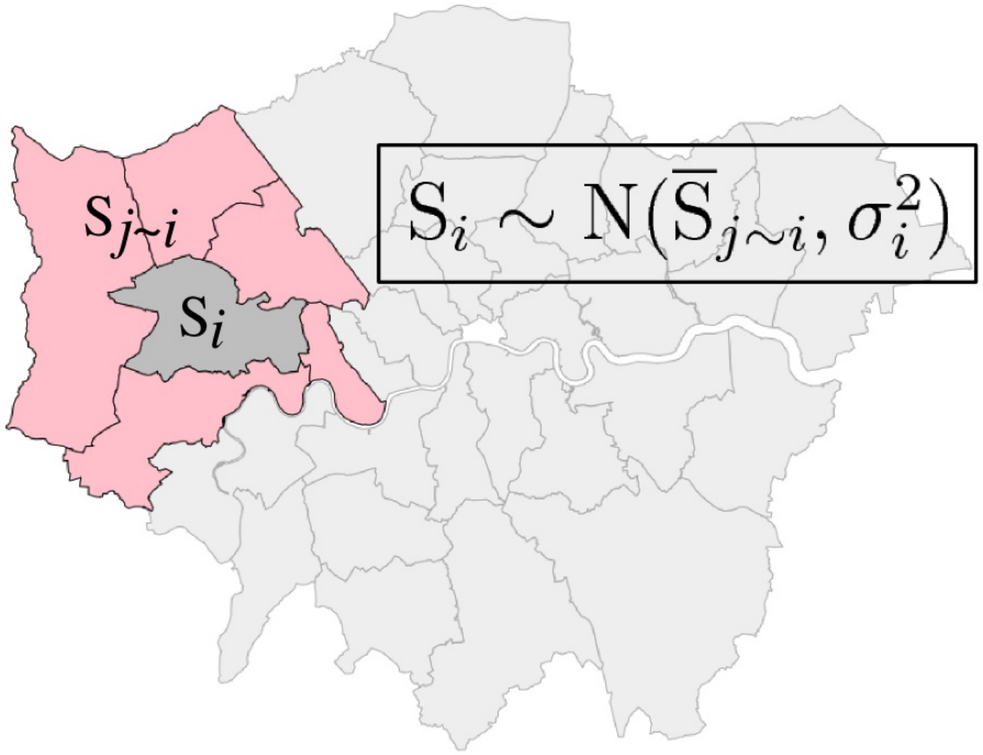




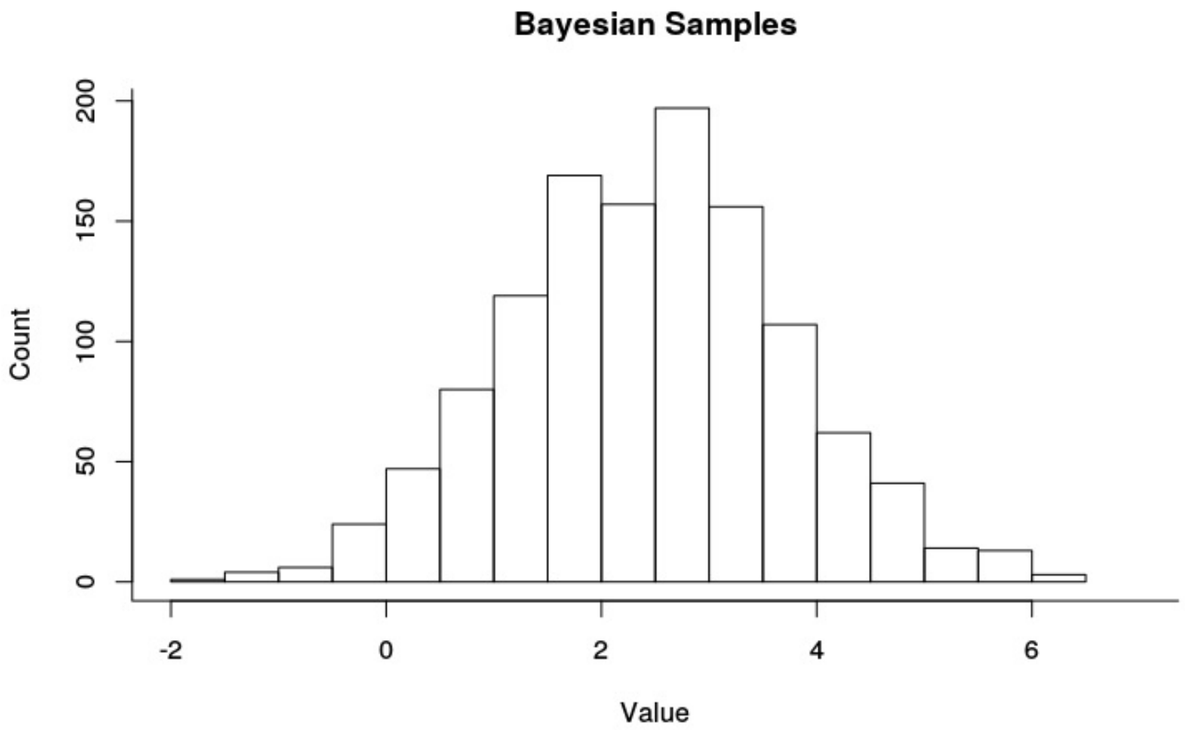
Model for Spatial Correlation

$$Y = X\beta + \mathbf{S}(x, y)$$

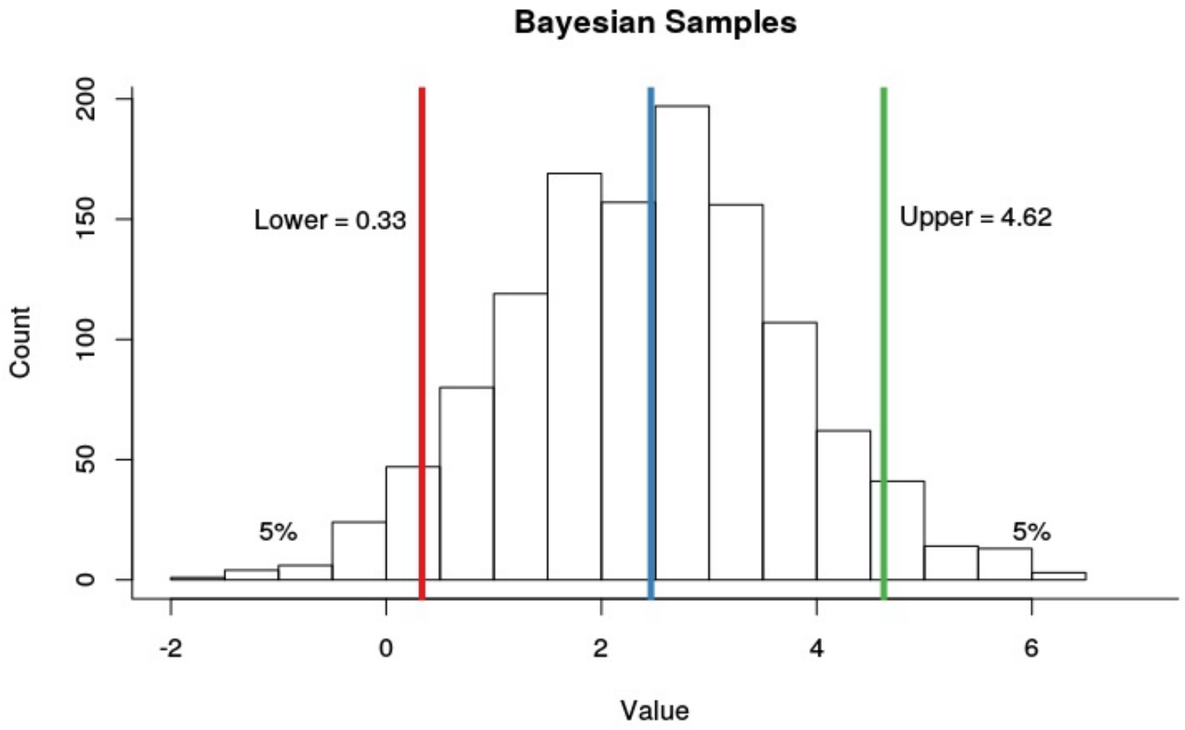
Conditional Autocorrelation



Bayesian Statistics



Bayesian Statistics



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