

# Big Data Workshop for Local Authorities

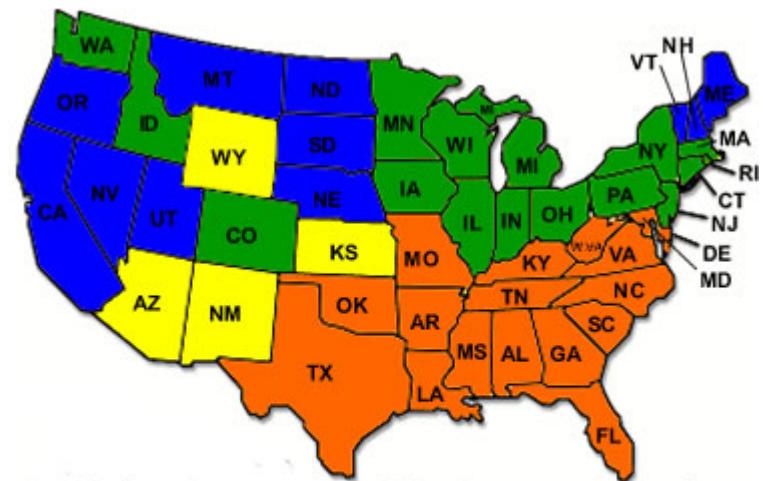
## Measuring Spatial Urban Segregation

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# Urban Segregation

- Simply considered as a measure of spatial separation of population groups in a region.
  - Ethnicity
  - Occupation
  - Income



In 1954, when the Supreme Court ruled against segregation, state laws varied widely.

- States shown in orange REQUIRED segregation.
- States shown in green PROHIBITED segregation.
- States shown in blue had NO SPECIFIC LAWS about segregation.
- States shown in yellow made segregation a LOCAL OPTION.

# The Dissimilarity Index

$$D = \frac{1}{2} \sum_{i,j} |p_{i,g} - p_{j,g}| / p_g$$

(Duncan and Duncan, 1955)

$i, j$ : index of spatial unit;

$p_g$ : total population of group  $g$ ;

$p_{\cdot g}$  : total population of group  $g$ ;

$p_{i,g}$ : total population of group  $g$  in spatial unit  $i$ ;

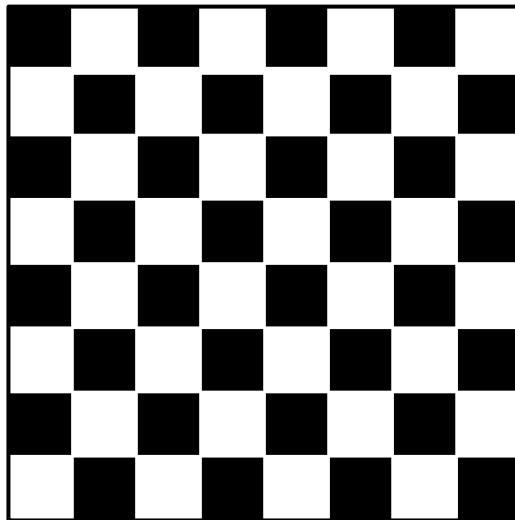
$p_{j,g}$  : total population of group  $g$  in spatial unit  $j$ ;

0: *no segregation and*

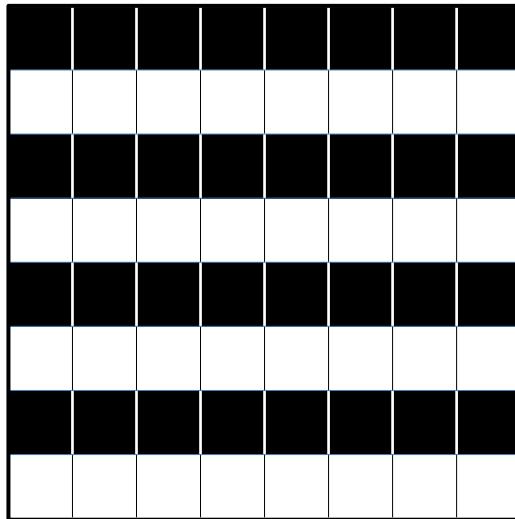
1: *complete segregation*

# Why Geographic Space matters?

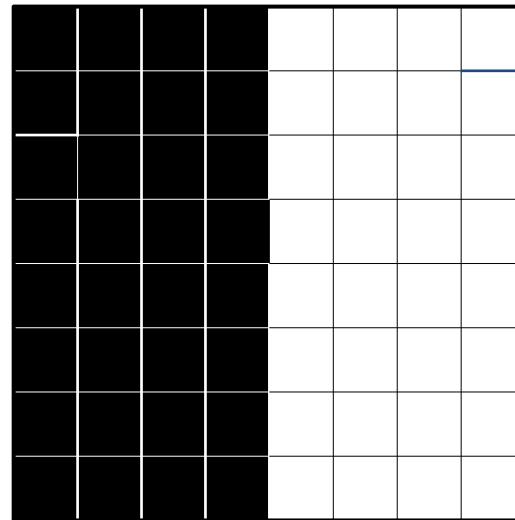
$D=1$



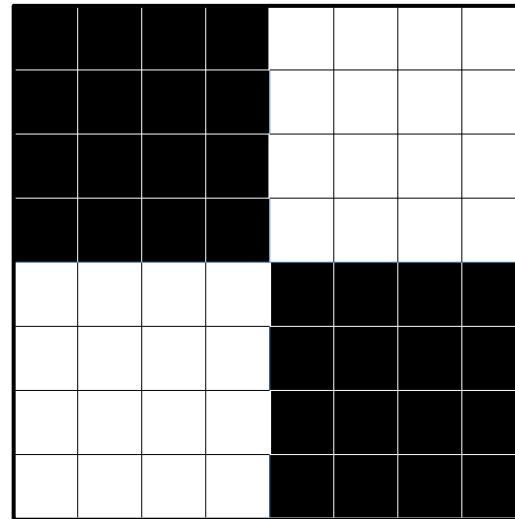
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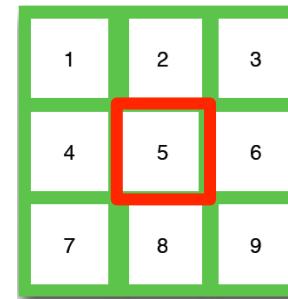
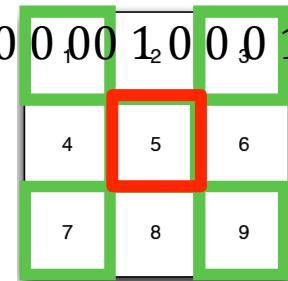
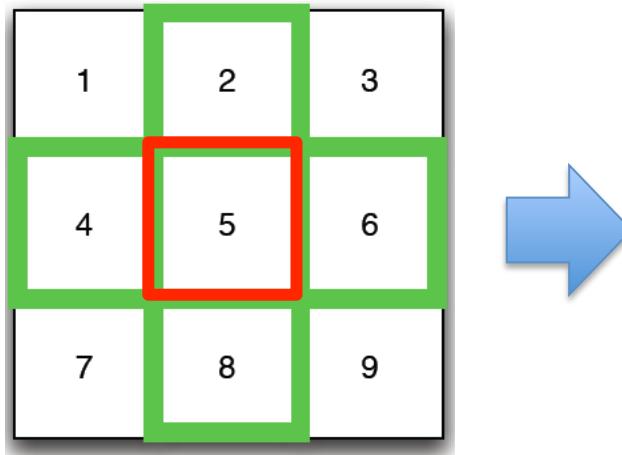
$D=1$



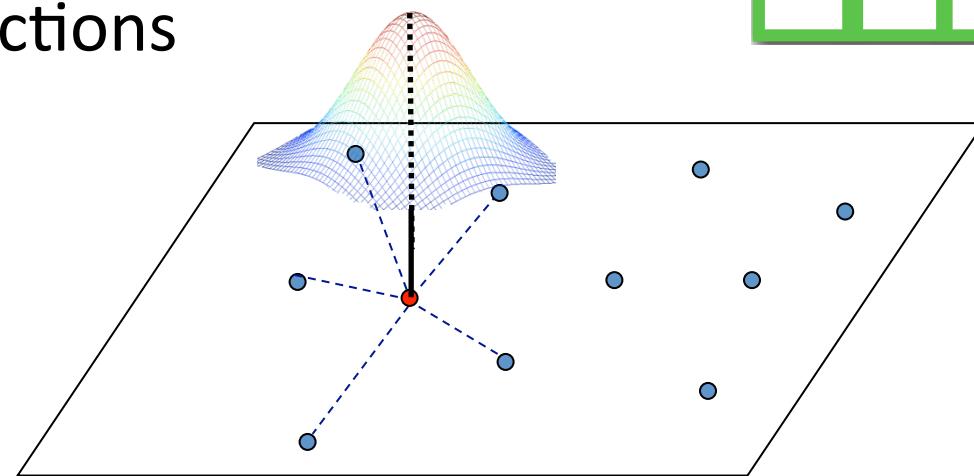
# How to incorporate spatial relationship?

- Spatial weight matrix

$$W = \begin{bmatrix} 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$



- Spatial kernel functions



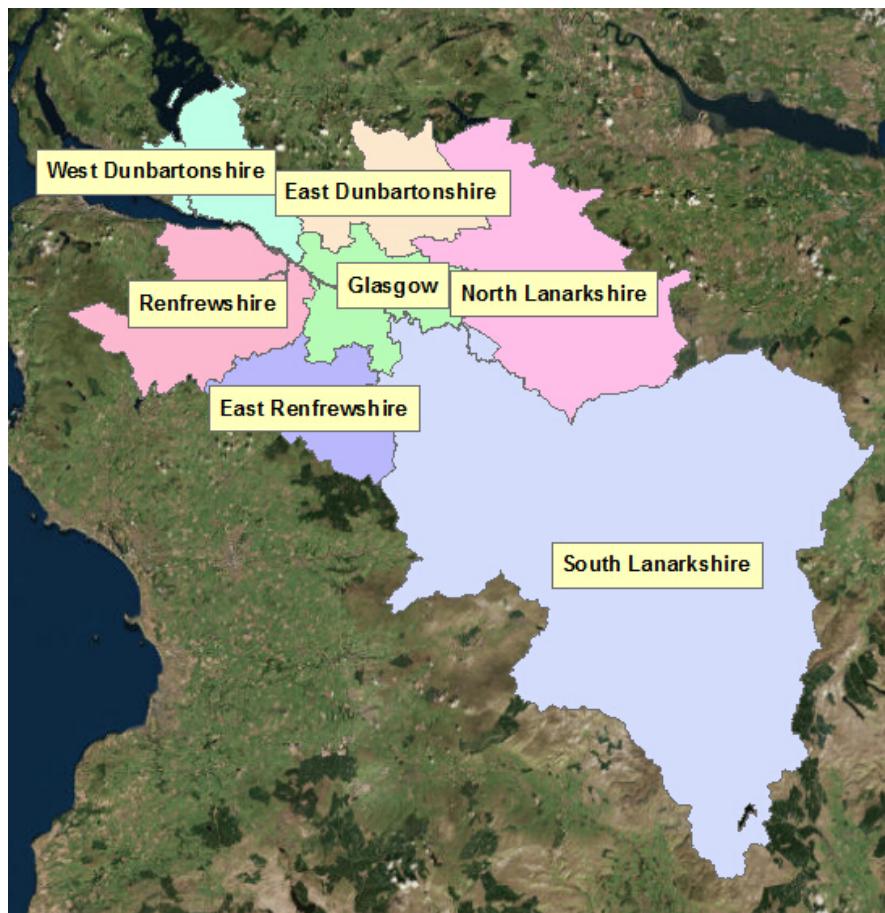
# A Spatial Extension of $D$

$$D(\text{adj}) = D - \sum i \uparrow \sum j \uparrow |w_{\downarrow ij}(z \downarrow i, g - z \downarrow j, g)| / \sum i \uparrow \sum j \uparrow w_{\downarrow ij}$$

(Morrill, 1991)

# An Empirical Example

## Greater Glasgow: Ethnicity



# Ethnicity Segregation in Great Glasgow

## -- Global Indices

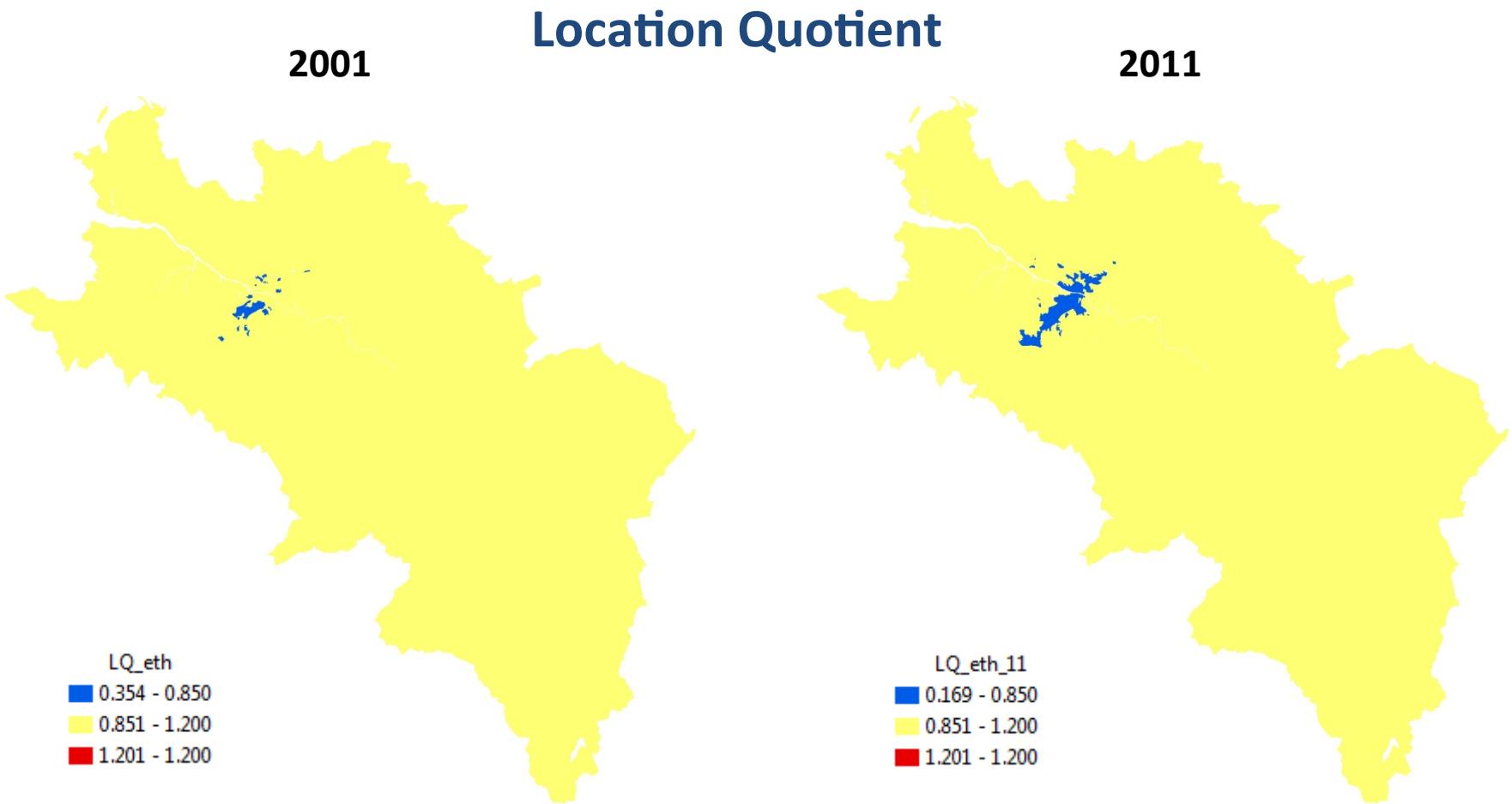
### White/Others

1. Dissimilarity index  $D$  ([Duncan and Duncan, 1955](#))
2. Spatial proximity (SP) ([White, 1983](#))
3. Adjusted dissimilarity index,  $D(\text{adj})$  ([Morrill, 1991](#))
4.  $D(w)$  ([Wong, 1993](#))
5.  $D(s)$  ([Wong, 1993](#))

Year	% of white	Geography	1	2	3	4	5
2001	97.1	2001 data zone	0.518	<b>1.012</b>	0.497	0.501	0.514
2011	94.2	2001 data zone	0.472	<b>1.643</b>	0.440	0.444	0.466

# Ethnicity Segregation in Great Glasgow

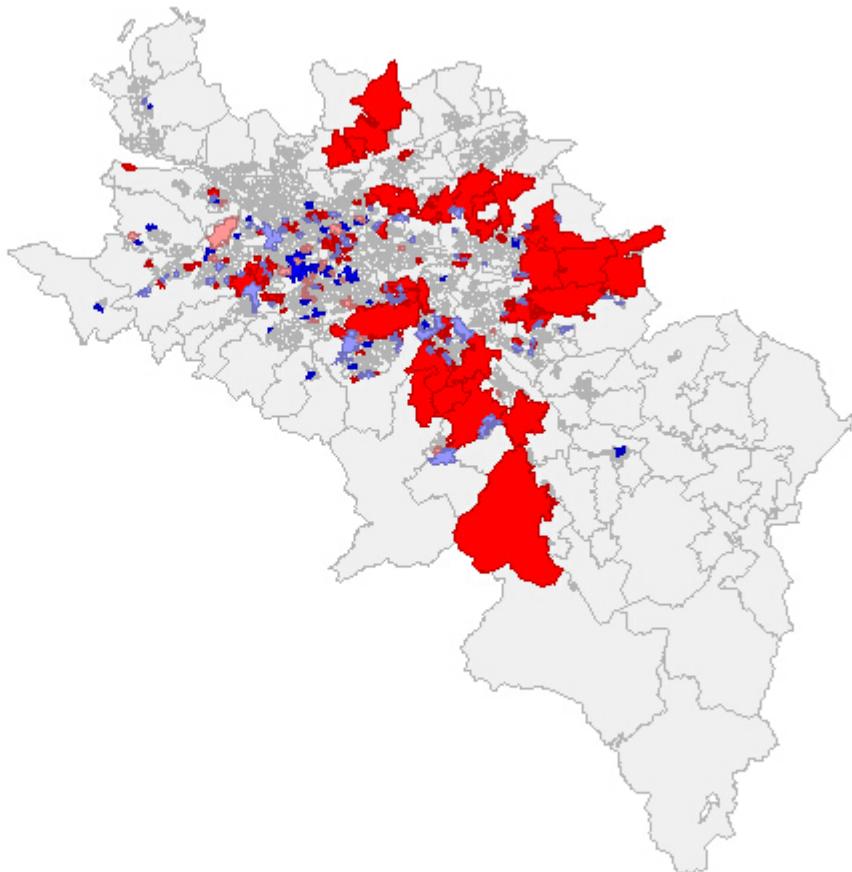
## -- Local Indices (1)



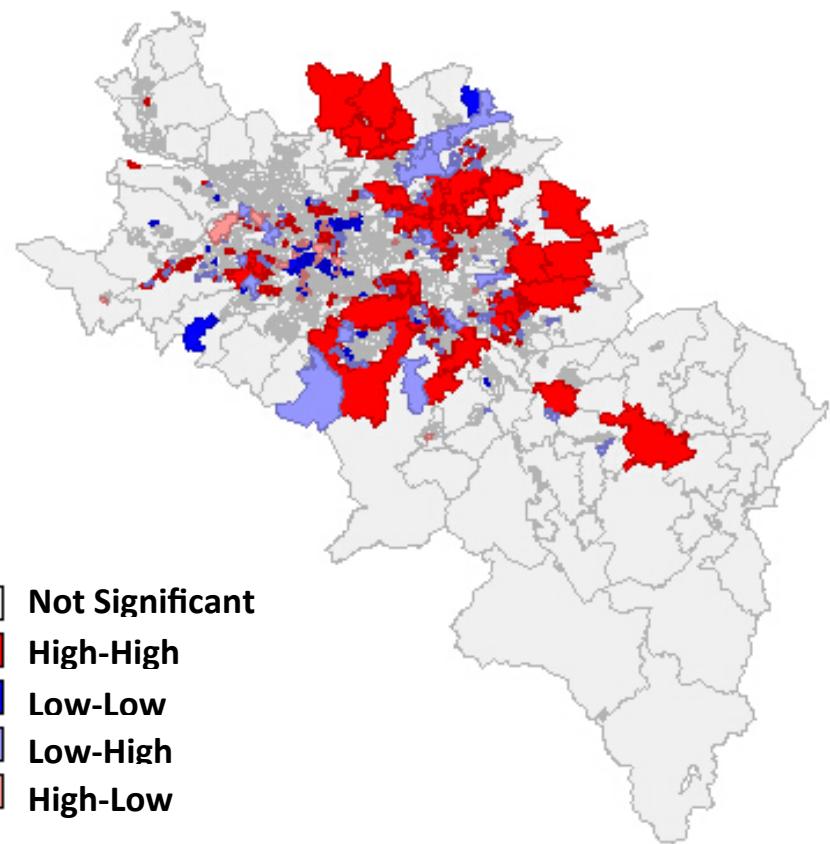
# Ethnicity Segregation in Great Glasgow -- Local Indices (2)

## Local Indicator of Spatial Autocorrelation

2001



2011



- Not Significant
- High-High
- Low-Low
- Low-High
- High-Low

# An issue with Spatial Measures

- Modifiable Area Unit Problem (MAUP) ([Openshaw, 1984](#))
  - Aggregation
  - Zoning

Effects of Aggregation

2	4	6	1
3	4	3	5
1	5	4	2
5	4	5	4

$$\bar{x} = 3.75$$
$$\delta^2 = 2.60$$

3	3.5
4.5	4
3	3
4.5	4.5

$$\bar{x} = 3.75$$
$$\delta^2 = 0.50$$

3.75	3.75
3.75	3.75

$$\bar{x} = 3.75$$
$$\delta^2 = 0.00$$

*Patterns are dependent upon the scale of observation!*

Effects of Zoning Systems

2.5	5.0	4.5	3.0
3.0	4.5	4.5	3.0

$$\bar{x} = 3.75$$
$$\delta^2 = 0.93$$

2.75	4.75	4.5	3.0
4.0	3.67		

$$\bar{x} = 3.75$$
$$\delta^2 = 1.04$$

4.0	1.0
4.0	3.67

$$\bar{x} = 3.17$$
$$\delta^2 = 2.11$$



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