Introduction of geospatial data visualization and geographically weighted regression (GWR)

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Study Background

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(2) Data are summarized in different levels.
   - State
   - County
   - Zip Code

(3) The goal is generating several geographic maps with color representing information of interests.

Tennessee

Zip Code	Zip City	County	Female Mortality Rate per 100K
37013	Antioch	Davidson	20.05
37072	Goodlettsville	Davidson	28.13
37076	Hermitage	Davidson	25.34
37080	Joelton	Davidson	29.39
37115	Madison	Davidson	31.52
37138	Old Hickory	Davidson	28.71
37189	Whites Creek	Davidson	34.24
37201	Nashville	Davidson	27.40
.	.	.	.
.	.	.	.
.	.	.	.

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- Fill in the color

  Who is who ?

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- It's called hexadecimal color codes.
  There are also RGB color function in R available.
  rgb(228,26,28,max=255)

8 Levels Between Orange and Red

1 2 3 4 5 6 7 8

More Colors ?!?!

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- Usage :
  color.scales <- colorRampPalette(c("orange", "red", "green"))
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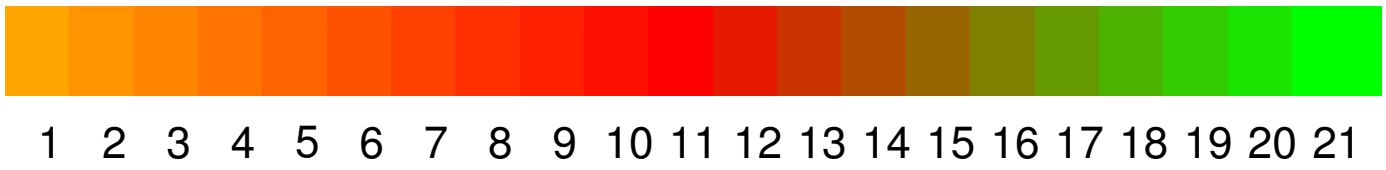

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Zip Code Boundaries

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- and another 1277 more lines !!!

Stracture of .shp File

```
Formal class 'SpatialPolygonsDataFrame' [package ``sp"] with 5 slots
 ..@ data :'data.frame':  964 obs.  of 8 variables:
 ..  ..$ AREA : num [1:964] 2.92e-03 2.34e-02 4.18e-03 2.02e-05 2.95e-05 ...
 ..  ..$ PERIMETER : num [1:964] 0.8641 1.3754 2.9457 0.0226 0.0326 ...
 ..  ..$ ZT47_D00_ :  int [1:964] 2 3 4 5 6 7 8 9 10 11 ...
 ..  ..$ ZT47_D00_I: int [1:964] 1 2 3 4 5 6 7 8 9 10 ...
 ..  ..$ ZCTA : Factor w/ 634 levels ``37010",``37012",..:  65 66 65 15 15 15 88 108 81 98 ...
 ..  ..$ NAME : Factor w/ 634 levels ``37010",``37012",..:  65 66 65 15 15 15 88 108 81 98 ...
 ..  ..$ LSAD : Factor w/ 1 level ``Z5":  1 1 1 1 1 1 1 1 1 1 ...
 ..  ..$ LSAD_TRANS: Factor w/ 1 level ``5-Digit ZCTA":  1 1 1 1 1 1 1 1 1 1 ...
 ..  ..- attr(*, ``data_types")= chr [1:8] ``F" ``F" ``N" ``N" ...
 ..@ polygons :List of 964
 ..  ..$ :Formal class 'Polygons' [package ``sp"] with 5 slots
 ..  ..  ..  ..@ Polygons :List of 1
 ..  ..  ..  ..  ..$ :Formal class 'Polygon' [package ``sp"] with 5 slots
 ..  ..  ..  ..  ..  ..  ..@ labpt :  num [1:2] -88 36.6
 ..  ..  ..  ..  ..  ..  ..@ area :  num 0.00292
 ..  ..  ..  ..  ..  ..  ..@ hole :  logi FALSE
 ..  ..  ..  ..  ..  ..  ..@ ringDir:  int 1
 ..  ..  ..  ..  ..  ..  ..@ coords :  num [1:169, 1:2] -88 -88 -88 -88 -88 ...
 ..  ..  ..  ..@ plotOrder:  int 1
 ..  ..  ..  ..@ labpt :  num [1:2] -88 36.6
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- Assumption : the zip code is saved with the order.

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- *polygon{graphics}*
- Useage :

$$polygon(x,\ y = NULL,\ density = NULL,\ angle = 45,\ border = NULL,\ col = NA,\ lty = par(\text{"lty"}),\ldots)$$

Representing Information with Colors

Zip Code	Female Mortality Rate per 100K	20% Quantile
37013	20.05	1
37072	28.13	4
37076	25.34	3
37115	22.52	2
37138	28.71	5
37189	34.24	5
37201	27.40	4
.	.	.
.	.	.
.	.	.

Representing Information with Colors

Zip Code	Female Mortality Rate per 100K	20% Quantile	Corresponding Color
37013	20.05	1	#9999FF
37072	28.13	4	#4C4CFF
37076	25.34	3	#6666FF
37115	22.52	2	#7F7FFF
37138	28.71	5	#3333FF
37189	34.24	5	#3333FF
37201	27.40	4	#4C4CFF
.	.	.	.
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- Now we are ready to plot !!!!

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- Brunsdon (1996), "Geographically Weighted Regression: A Method for Exploring Spatial Nonstationarity", Geographical analysis, Vol. 28, No. 4, P.281.

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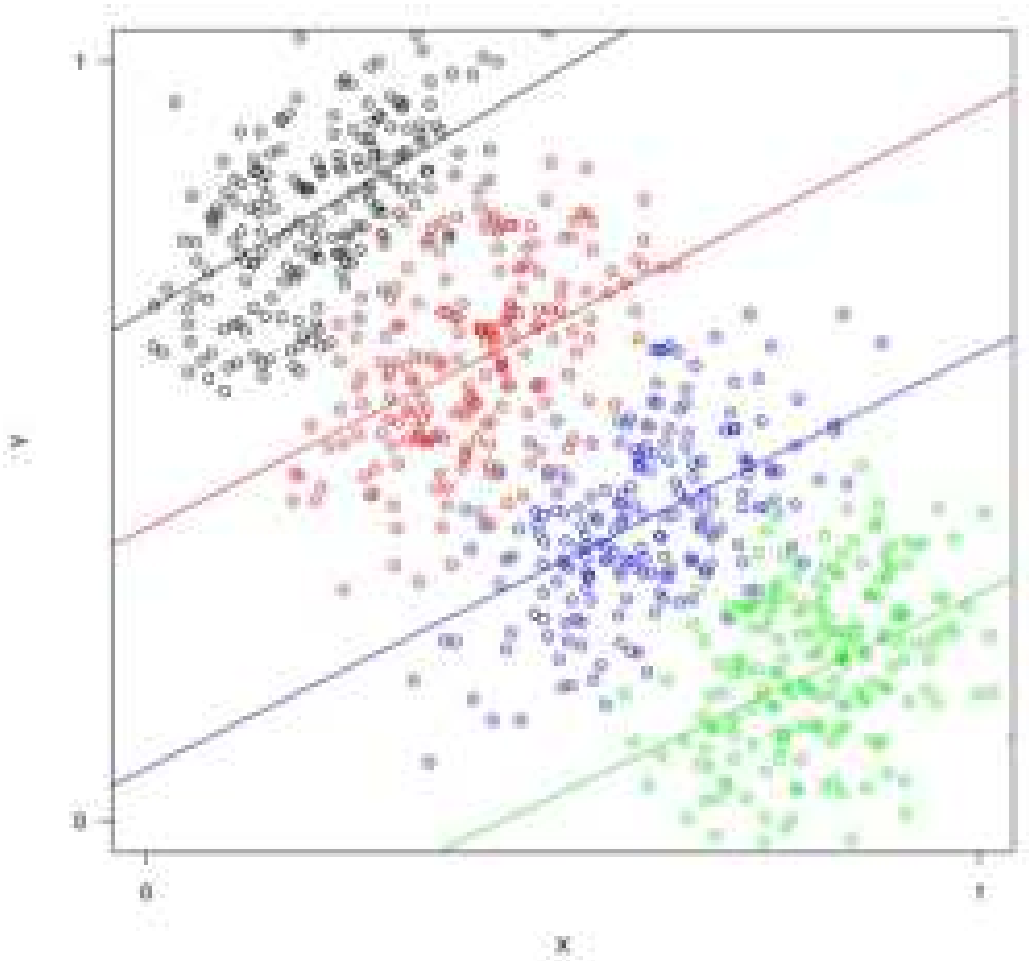
- Variations in relationships over space, such as those described above, are referred to as spatial nonstationarity.
- Simple linear model is not not appropriate, but widely used in early 90s for the data with geographic information.

Simpson's Paradox



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- Key difference : We estimate a set of regression coefficients for each observation (i).
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- First law of geography: everything is related with everything else, but closer things are more related.

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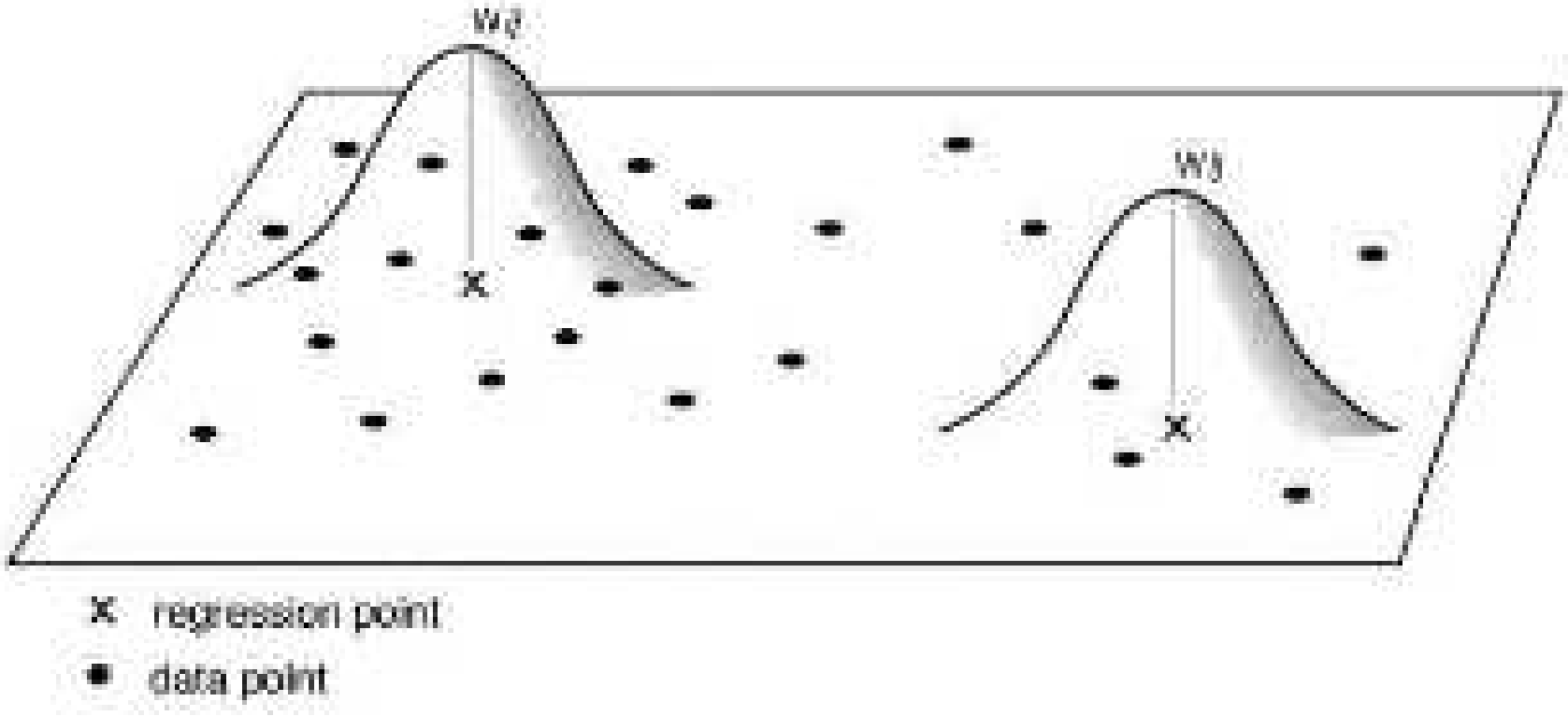
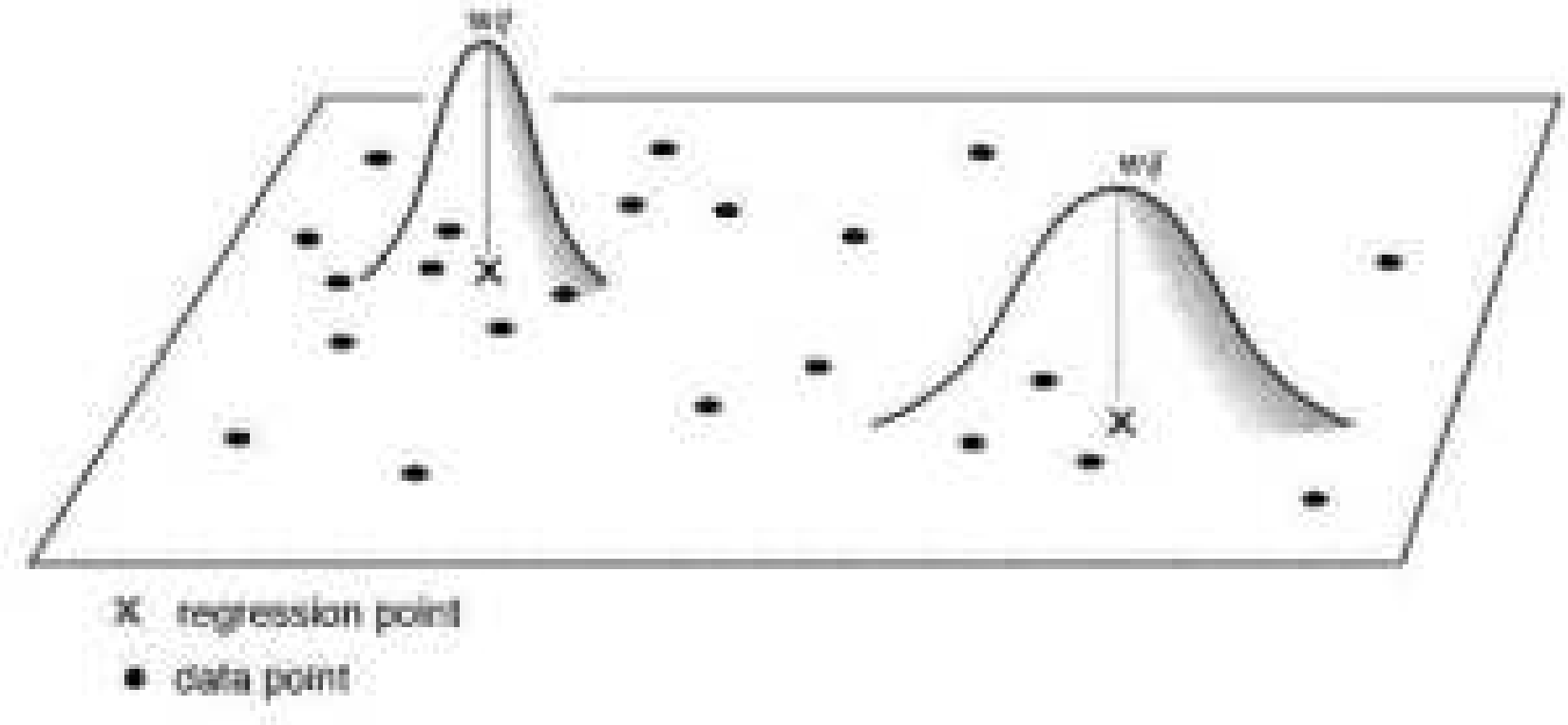
- Bandwidth specifies shape of weights curve.
- Whether we will define our bandwidth based on distance (fixed) or number of neighbors (adaptive).

Fixed Bandwidth



Adaptive Bandwidth



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- Relationship between crime and income & housing.

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- Returns the cross-validation bandwidth.

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- Another regression method called Geographically Weighted Quantile Regression (GWQR), as well as the corresponding R package are under development.
- By integrating the features of QR into GWR, the GWQR permits researchers to investigate the spatial non-stationary across both space and the whole distribution of a dependent variable.

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- Thank you !! & Questions ??