TU Delft

Introduction to *Urban* Data Science

Exploring Space in Data

(EPA1316)

Lecture 8

Trivik Verma

Groups (28/09-16/10)

Form groups of ***4 students*** each. Each student needs to be part of a group. If you are going to drop the course, don't sign up for the final project as that may delay the progress of other students.

- If you have decided on a group of 4 and your partners haven’t joined your group yet, do it right away
- If you haven’t found a group, join a group that has 2 or 3 people

Last Time

- Introduction to Networks
- The need to represent space formally
- Spatial weights matrices
  - What
  - Why
  - Types
- The spatial lag

Today

- Exploratory Spatial Data Analysis (ESDA)
- Spatial Autocorrelation Measures
  - Global
  - Local

[Exploratory]

Focus on discovery and assumption-free investigation

[Spatial]

Patterns and processes that put space and geography at the core

[Data Analysis]

Statistical techniques

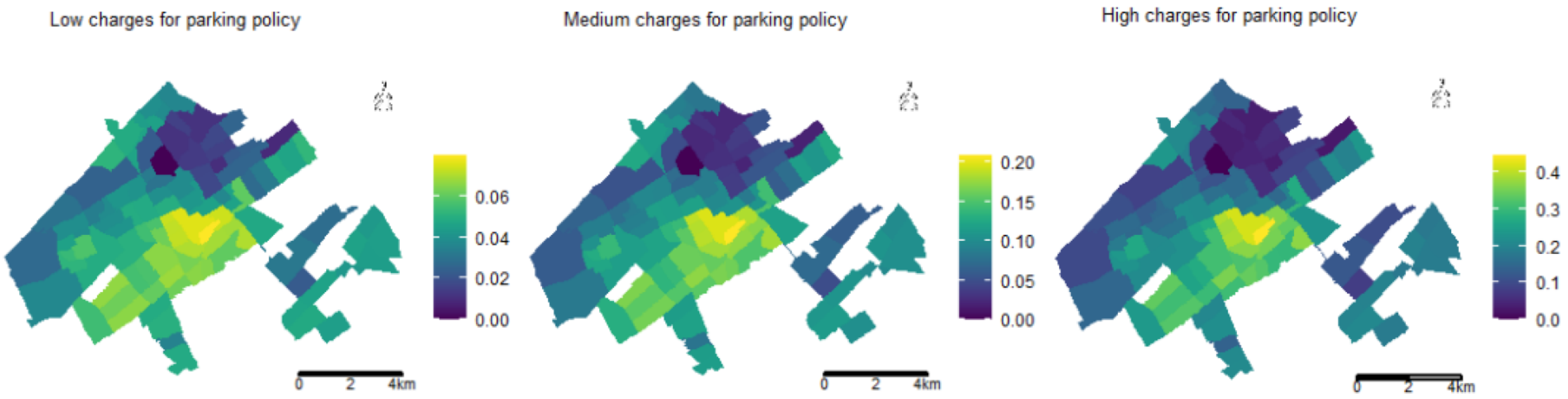
Questions that ESDA helps…

Answer

- Is the variable I'm looking at concentrated over space?
- Do similar values tend to locate close by?
- Can I identify any particular areas where certain values are clustered?

Ask

- What is behind this pattern?
- What could be generating the process?
- Why do we observe certain clusters over space?



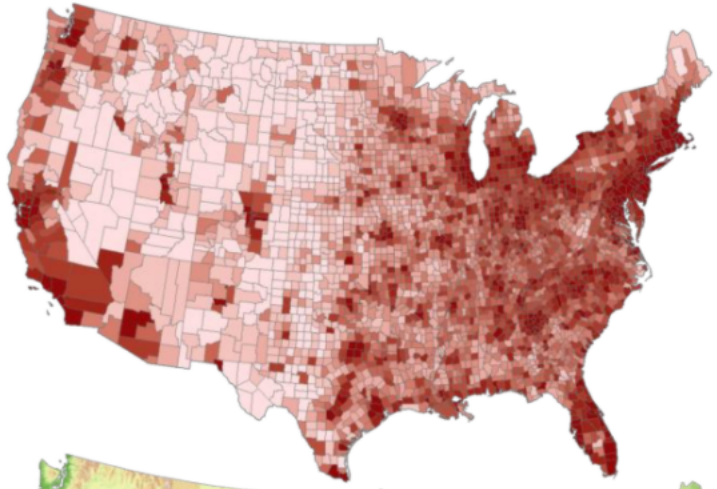
Net emission reduction in the mobility sector for different neighbourhoods of the Hague under different car parking charging policies ceteris paribus

The first law of geography:

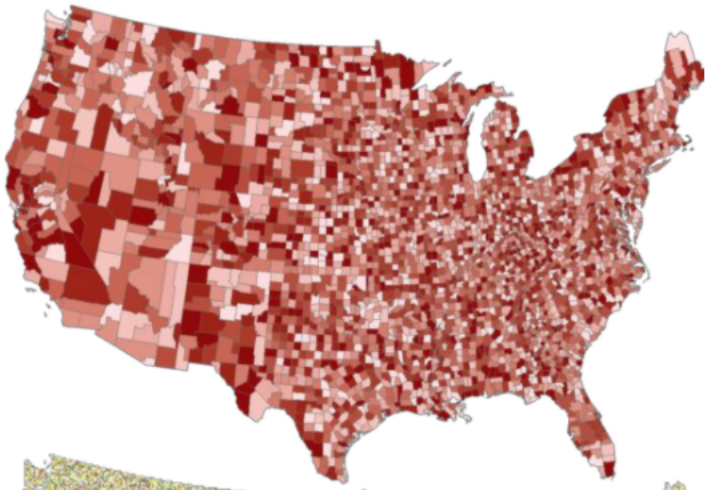
"Everything is related to everything else, but near things are more related than distant things."

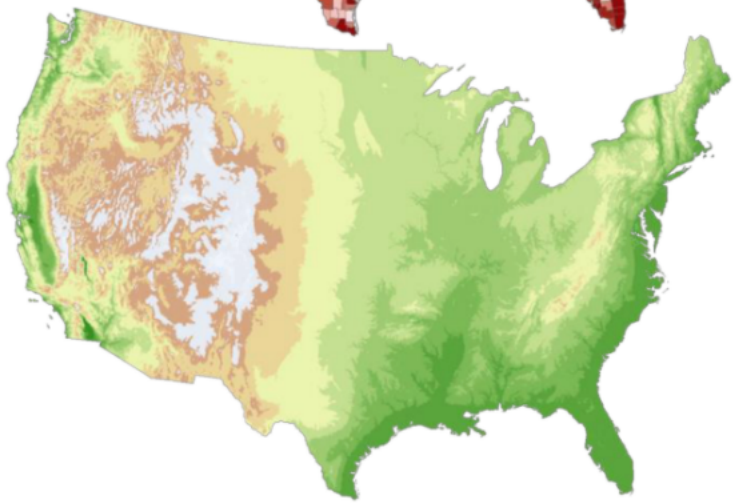
Waldo R. Tobler (Tobler 1970)

If features were randomly distributed



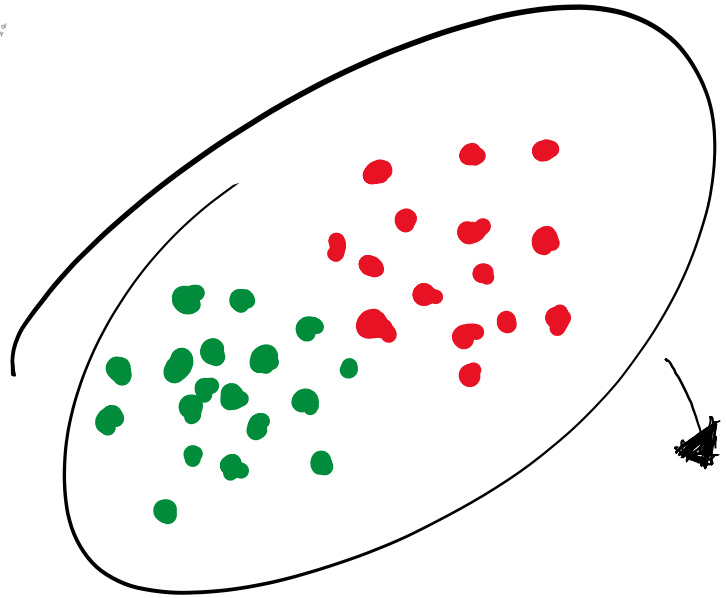
population density map of the US



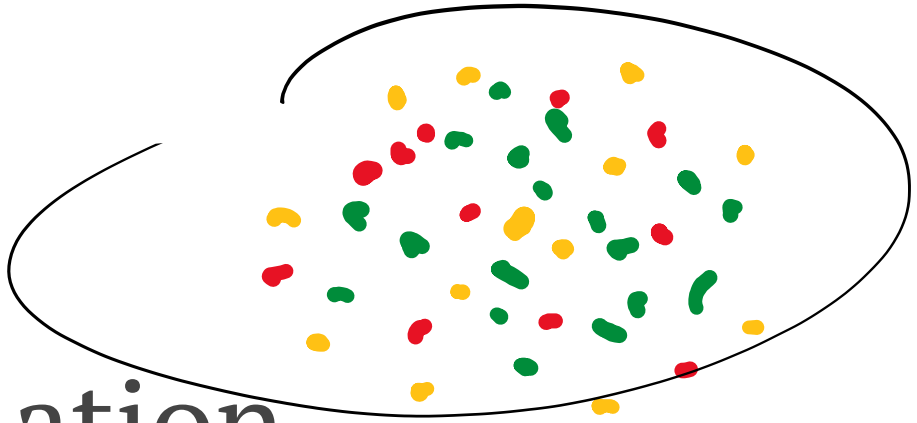


elevation map of the US

HOW ARE FEATURES CLUSTERED?



Clustered



non-clustered regions

Spatial Autocorrelation

1. Quantitative
2. Objective
3. Degree of similarity
4. where does it occur?

Spatial Autocorrelation

- Statistical representation of Tobler's law
- Spatial counterpart of traditional correlation

Degree to which similar values are located in similar locations

Spatial Autocorrelation

Two flavours:

- Positive: similar values → similar location *(close by)*
- Negative: similar values → dissimilar location *(further apart)*

Examples

Positive SA: income, poverty, vegetation, temperature…

Negative SA: supermarkets, police stations, fire stations, hospitals…

Scales

[Global] Clustering: do values tend to be close to other (dis)similar values?

[Local] Clusters: are there any specific parts of a map with an extraordinary concentration of (dis)similar values?

Global Spatial Autocorrelation

Global Spatial Autocorr.

“Clustering”

Overall trend where the distribution of values follows a particular pattern over space

[Positive] Similar values close to each other (high-high, low-low)

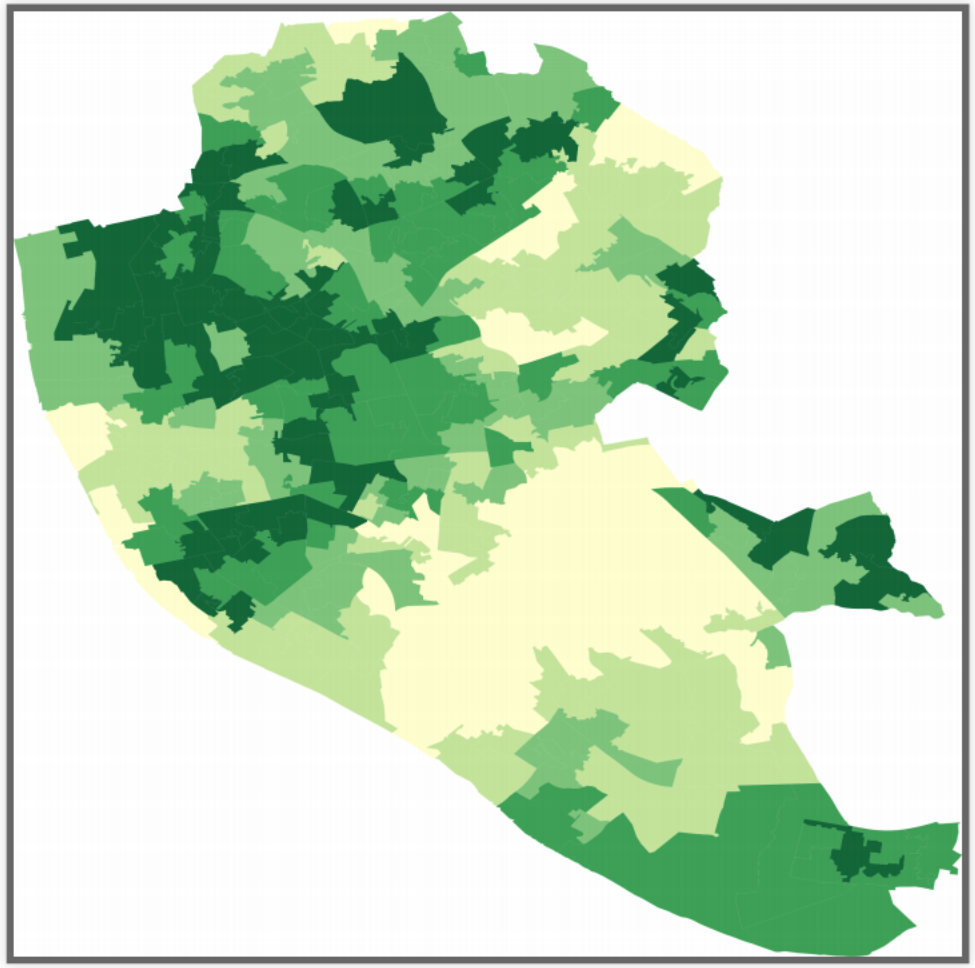
[Negative] Similar values far from each other (high-low)

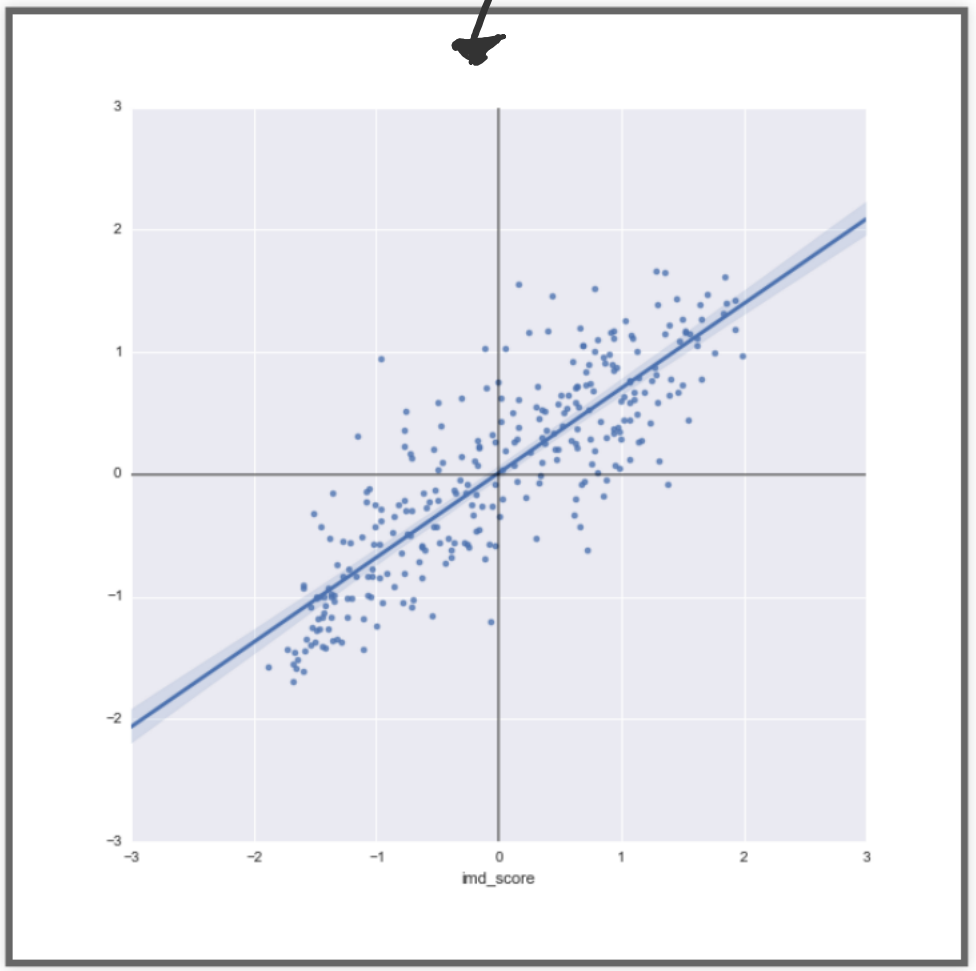
How to measure it???

Moran Plot

- Graphical device that displays a **variable** on the horizontal axis against **its spatial lag (Y_il – previous lecture)** on the vertical one
- Variable and spatial weights matrix are preferably standardized
- Assessment of the overall association between a variable in each location and, in its *neighbourhood*

from the lab exercises





Break

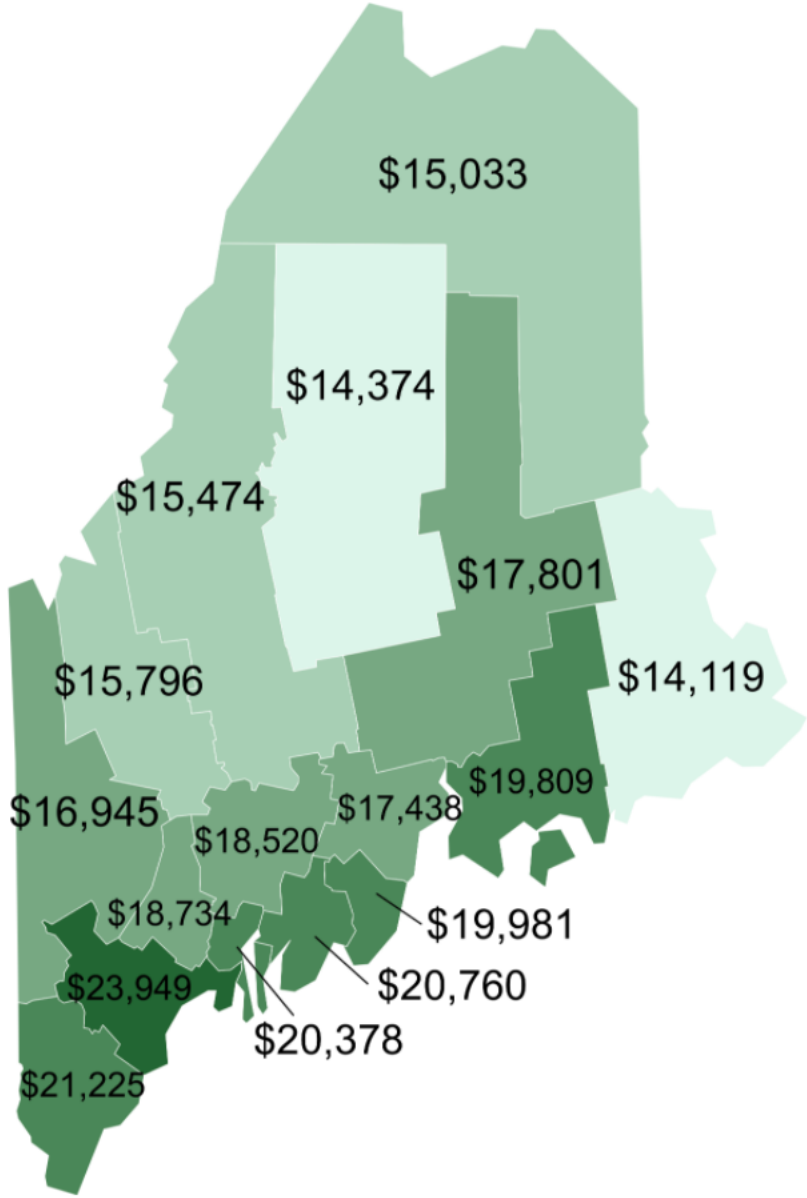
WATER

WALK

COFFEE OR TEA

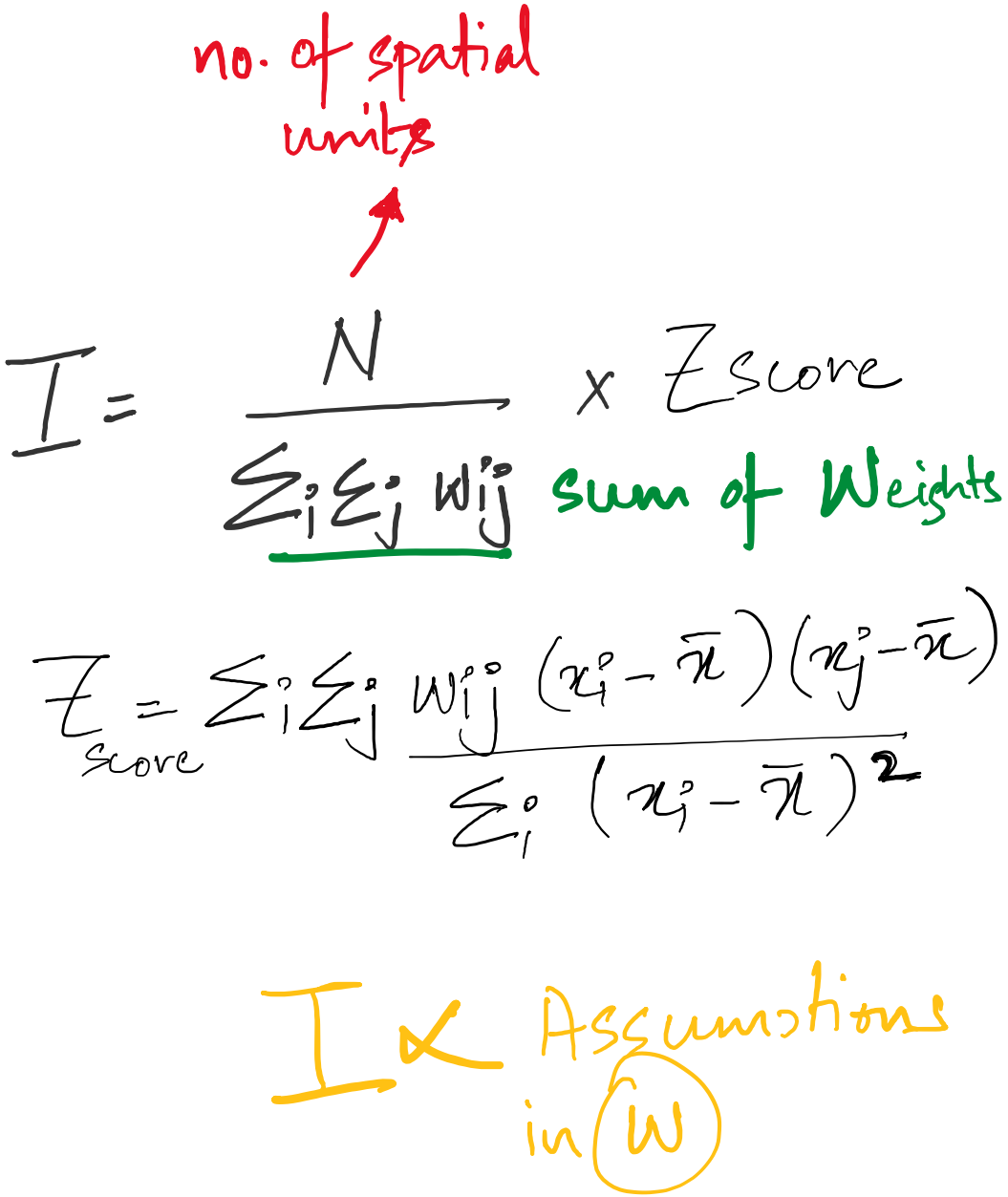
MAKE FRIENDS

Let’s start with a working example: 2010 per capita income for the state of Maine.



Moran's I

- Formal test of global spatial autocorrelation
- Statistically identify the presence of clustering in a variable
- Slope of the Moran plot
- Inference based on how likely it is to obtain a map like observed from a purely random pattern



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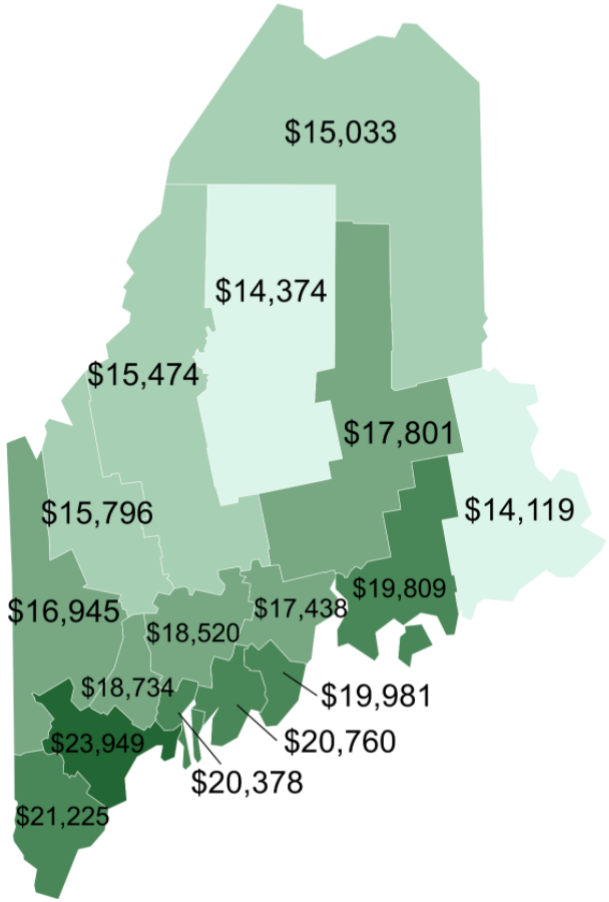
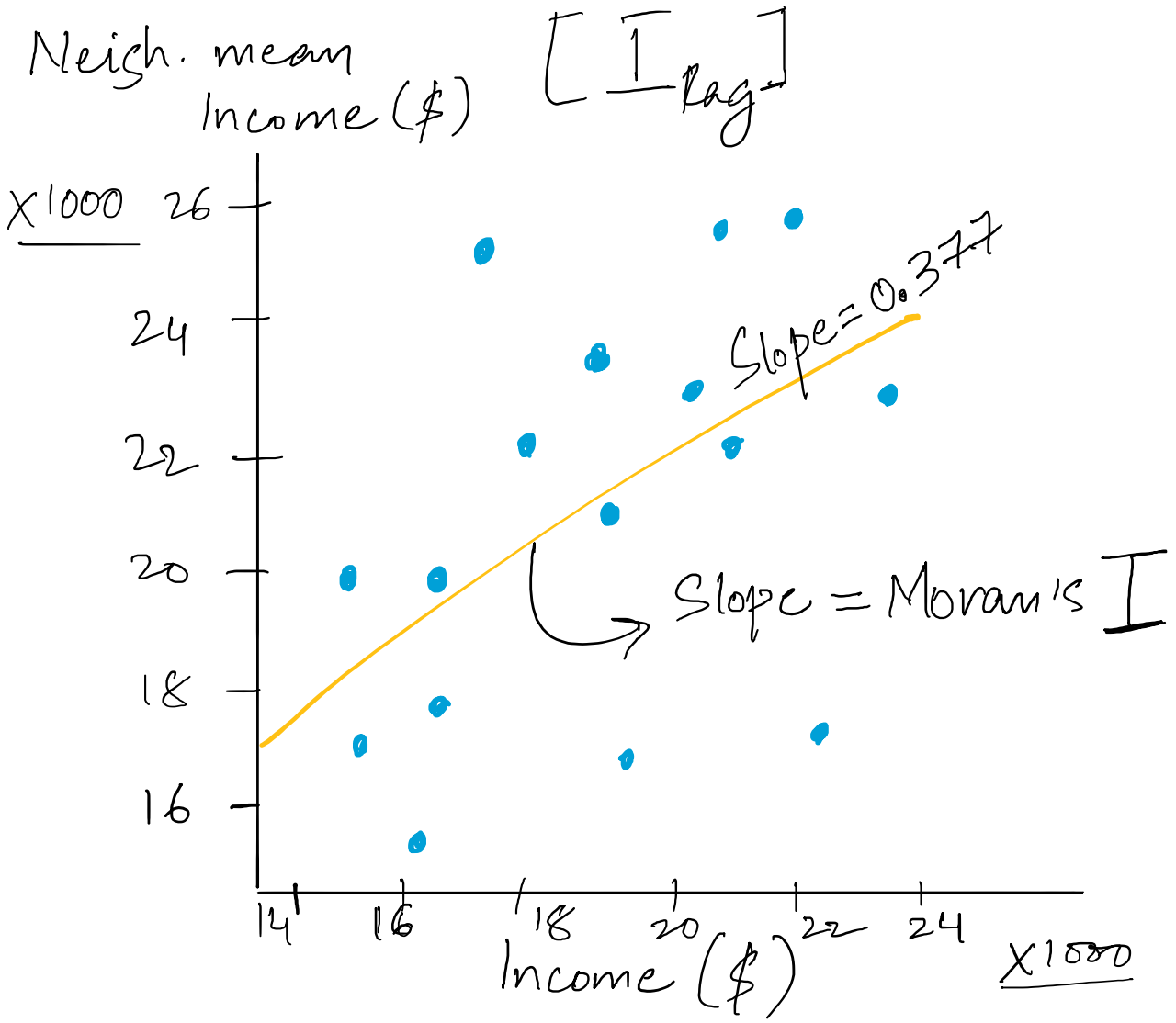
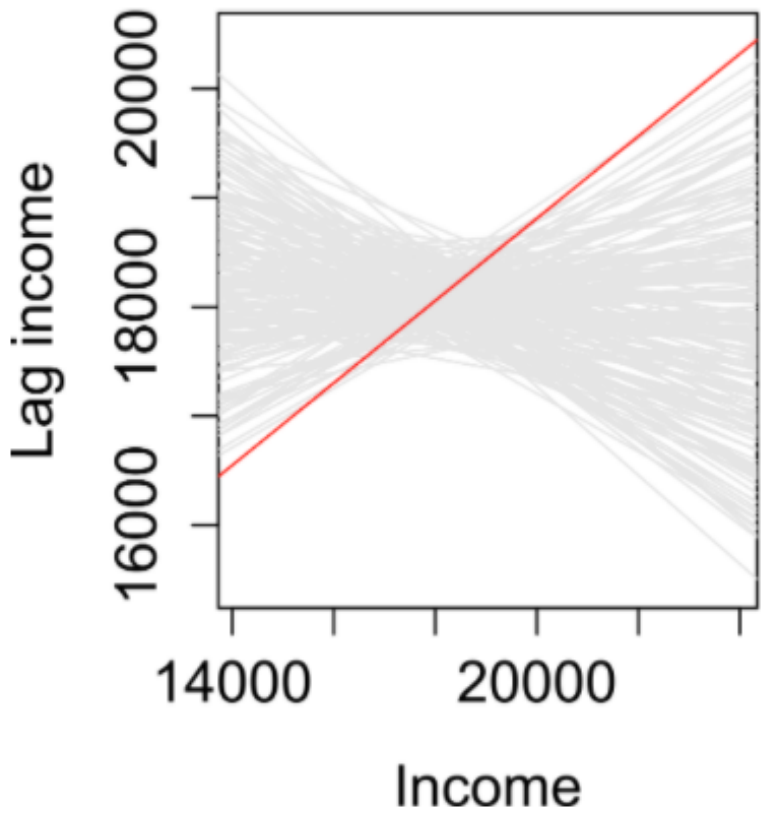
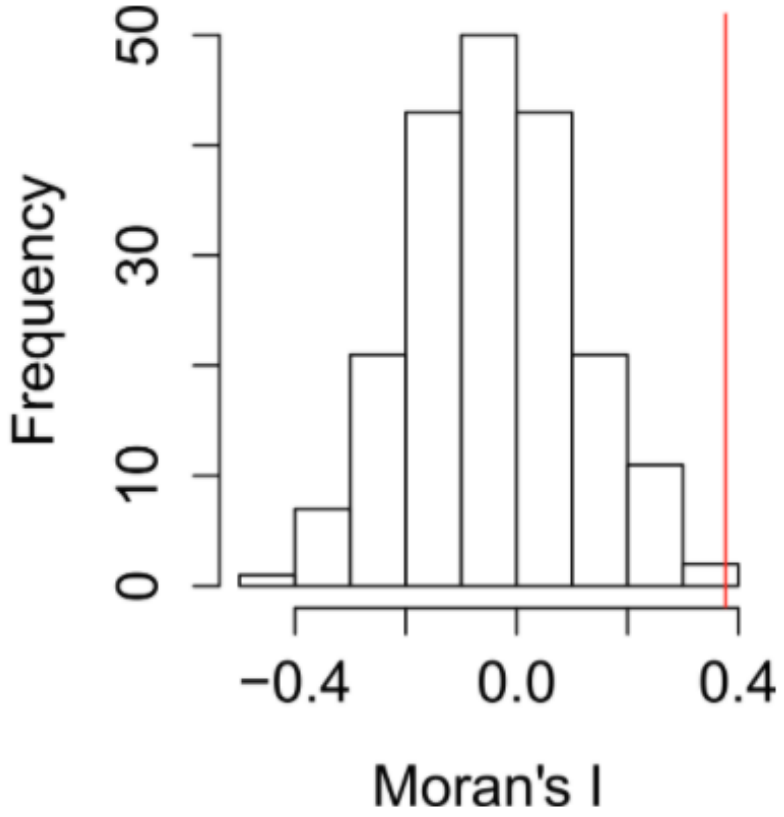




How significant is this I statistic?





Local Spatial Autocorrelation

Local Spatial Autocorr.

"Clusters"

Pockets of spatial instability

Portions of a map where values are correlated in a particularly strong and specific way

[High-High] + SA of high values (hotspots)

[Low-Low] + SA of low values (coldspots)

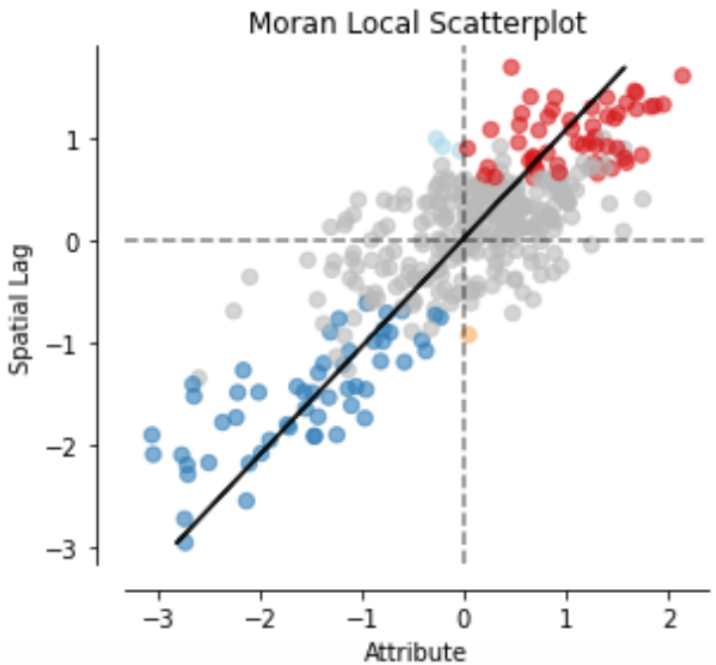
[High-Low] - SA (spatial outliers)

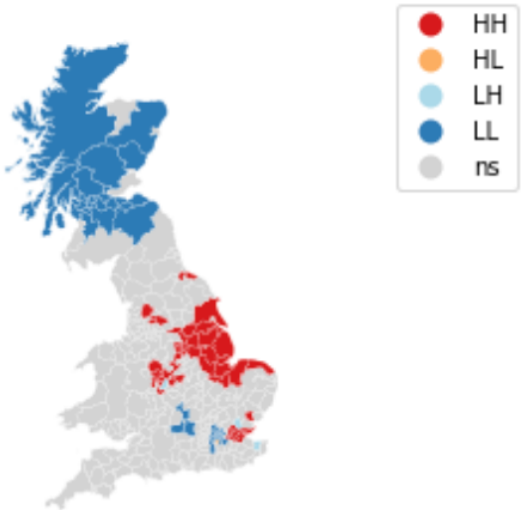
[Low-High] - SA (spatial outliers)

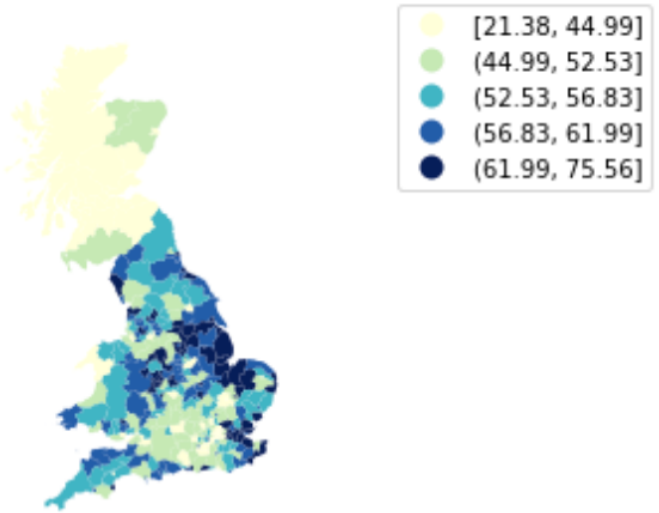
What is LISA?

Local **I**ndicators of **S**patial **A**ssociation

- Statistical tests for ***spatial cluster detection*** → Statistical significance
- **Compares** the **observed** map with many **randomly** generated ones to see how likely it is to obtain the areas of unusually high concentration


Moran Local Scatterplot
Spatial Lag
Attribute
1
0
−1
−2
−3
−3
−2
−1
0
1
2


HH
HL
LH
LL
ns


[21.38, 44.99]
(44.99, 52.53]
(52.53, 56.83]
(56.83, 61.99]
(61.99, 75.56]

Recapitulation

ESDA is a family of techniques to explore and spatially interrogate data

Main function: characterise **spatial autocorrelation**, which can be explored:

- **Globally** (e.g. Moran Plot, Moran ' s I)
- **Locally** (e.g. LISAs)

For next class..

Finish Lab 05 to practice programming

Submit Homework 05 for peer review on Peer

Submit Assignment 2 – due in **Week 5** on Sunday at **2330**

See "To do before class" for every lecture (~ 1 hour of self study)

Read paper for **Discussion** session before every Friday

Post questions on the **Discussion** forum on Brightspace (especially on **ESDA** for this week)