INTRODUCTION TO GIS ANALYSIS

Turning Maps Into Knowledge

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OVERVIEW OF TOPICS

- What is GIS?
- Spatial Data Types
- Overview of GIS Analysis
- Descriptive vs. Inferential Techniques in GIS Analysis
- Descriptive Analysis Example: Point Distribution
- Inferential Analysis Example: Moran's I
- Application Domains
- Case Study: Innovations in Polio Mapping
- Summary
- Workshop Details

WHAT IS GIS?

- GIS stands for *Geographical Information System*
- Computer systems that store, process or visualise geographical data
- Provide virtual representation of Earth in both space and time
- Examples: Google Earth, ArcGIS, The Gazetteer of Historical Australian Places (GHAP)

SPATIAL DATA TYPES

RASTER

- Spatial data represented in pixels or grids
- Raw satellite imagery is an example of pixel-based raster data
- Often used for the analysis of continuous data (elevation, temperature, precipitation, etc)

VECTOR

- Spatial data represented by geometric objects
- Points, lines, and polygons
- Defined by coordinates (e.g., lat, lon)
- Often used for the analysis of discrete data (roads, cities, boundaries, etc)

OVERVIEW OF GIS ANALYSIS

- Is essentially geospatial analysis on GIS data
- Involves a variety of techniques ranging from traditional statistical methods, to spatial-specific statistical methods. There are also special techniques for spatiotemporal data.
- Analysis is often statistical, but not necessarily so. Data mining techniques, such as network analysis, are also included.
- Artificial intelligence can also be used for GIS analysis, and this is very exciting!
- Common domain applications include criminology, epidemiology, environmental science, etc.

DESCRIPTIVE VS INFERENTIAL TECHNIQUES IN GIS

- Descriptive techniques involve describing a dataset rather than trying to make inferences about the underlying phenomenon.
  - Point distribution analysis
  - Visualisations such as heat maps
  - Grouping and summarising location data
- Inferential techniques involve looking at patterns in a dataset and seeing whether they can be generalised as properties of the underlying phenomenon.
  - Hypothesis testing
  - Predictions and forecasting

DESCRIPTIVE GIS ANALYSIS EXAMPLE: POINT DISTRIBUTION

- Geo Midpoint:

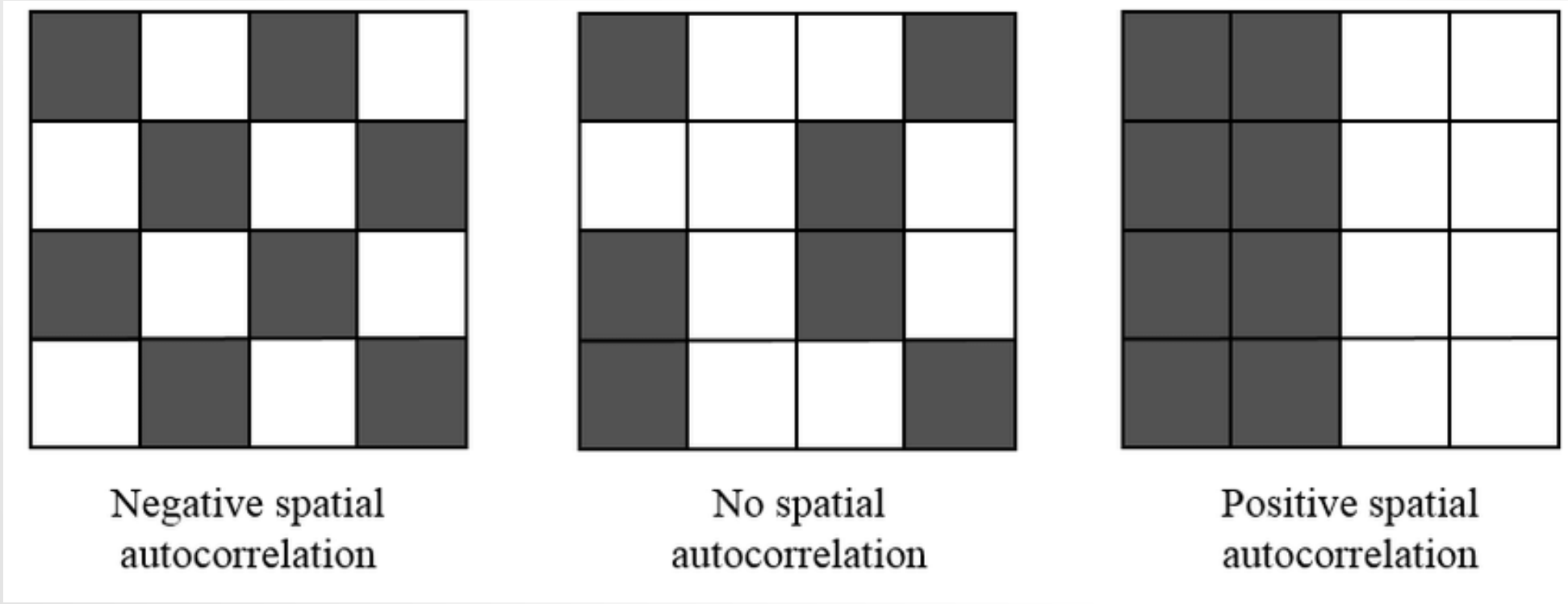
(-31.42604233,149.07859643)

- Displacement Stats:
  - Mean: ~720km
  - Median: ~636km
  - Min: ~2km
  - Max: ~3218km

INFERENTIAL GIS ANALYSIS EXAMPLE: MORAN'S I

- Moran's I is a statistic that measures spatial autocorrelation, indicating how similar objects are to their neighbours
- Values range from -1 (perfect dispersion) to +1 (perfect clustering), with 0 indicating a random pattern; positive values mean similar values cluster together.
- Used in fields like environmental science and epidemiology to analyse spatial patterns such as disease spread or environmental variations.
- Moran's I is conducted as part of a hypothesis test

INFERENTIAL GIS ANALYSIS EXAMPLE: MORAN'S I



(Amaya, Bastidas-Arteaga, Schoefs, Munoz, & Sanchez-Silva, 2019)

APPLICATION DOMAINS

- Applicable wherever there is geospatial data!
- Disaster management and response – tracking and predicting natural disasters
- Urban planning – land use analysis, spatial optimisation for service location
- Crime analysis and public safety – hot spot analysis for assigning police patrols
- Transportation and logistics – planning optimal bus routes, optimising postal deliveries
- Public health and safety – tracking disease spread and identifying hot spots

CASE STUDY: INNOVATIONS IN POLIO MAPPING

SUMMARY

- A Geographic Information System (GIS) is a computer-based tool that allows for storing, visualising, and analysing geographic data, used in applications ranging from Google Earth to ArcGIS, to GHAP.
- Raster data uses a grid of pixels to represent spatial information, while vector data uses geometric objects. The former is better suited to continuous information (e.g., temperature) while the latter is better suited to discrete information (e.g., cities)
- GIS analysis encompasses geospatial analysis using GIS data, incorporating traditional and spatial statistics, data mining, and AI.
- Descriptive GIS techniques describe data using methods like point distribution analysis and heat map visualisations, while inferential techniques aim to generalise findings from data patterns through hypothesis testing and predictive modelling.
- GIS analysis has many useful domains of application, many of which are life-saving!

WORKSHOP INFORMATION

- There will be an *Introduction to GIS Analysis* workshop tomorrow at 1:30 pm
- The workshop will take place at room K201
- The exercises will cover:
  - Point distribution analysis
  - Spacetime point distribution analysis
  - Moran's I
- Please attend if you're interested!

QUESTIONS?