

Introduction to spatial statistics

ST733 – Spatial Statistics

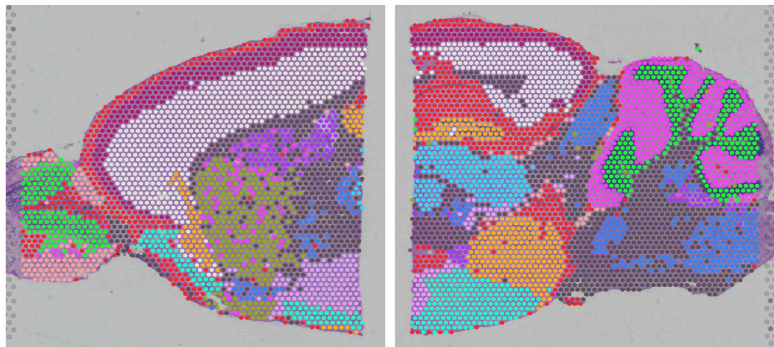
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Spring, 2026

Introduction

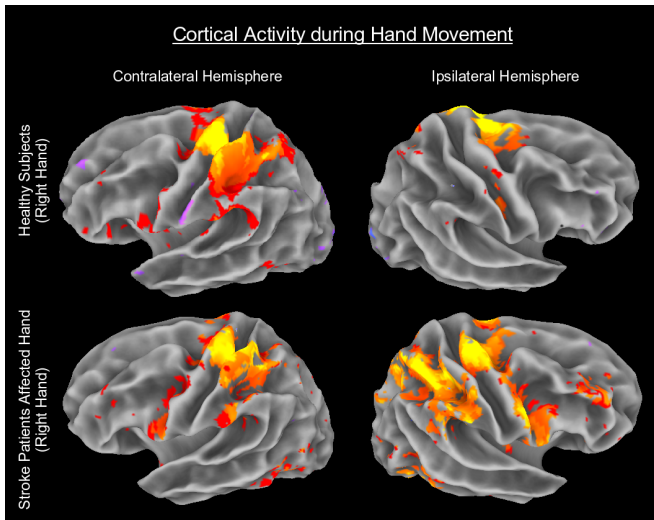
- ▶ Spatial data refers to data where each point is associated with a spatial location (lat/lon, state, cell, etc)
- ▶ Virtually all data is spatial, although not all data need be analyzed using spatial methods
- ▶ As a result, there are many application areas...

Examples of spatial data - spatial transcriptomics

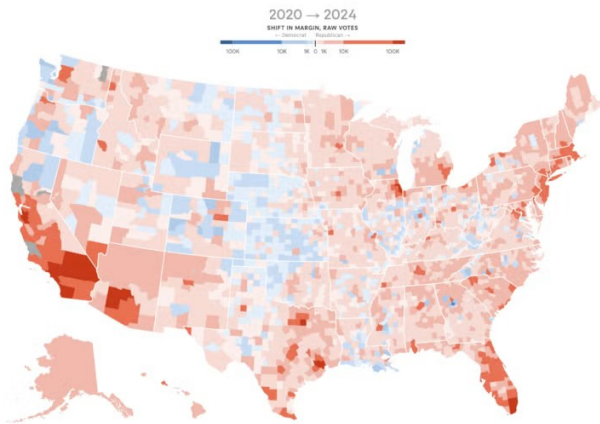


<https://sib-swiss.github.io/spatial-transcriptomics-training/>

Examples of spatial data - fMRI



Examples of spatial data - political/economic

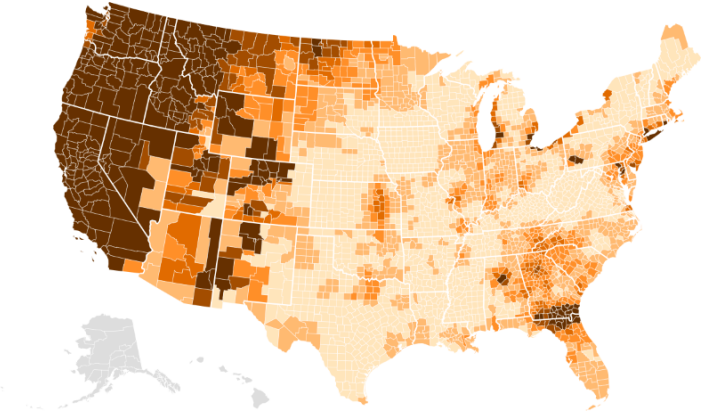


<https://why.org/articles/2024-presidential-election-results-republican-shift/>

Examples of spatial data - environmental

Estimated days with unhealthy air quality, 2024

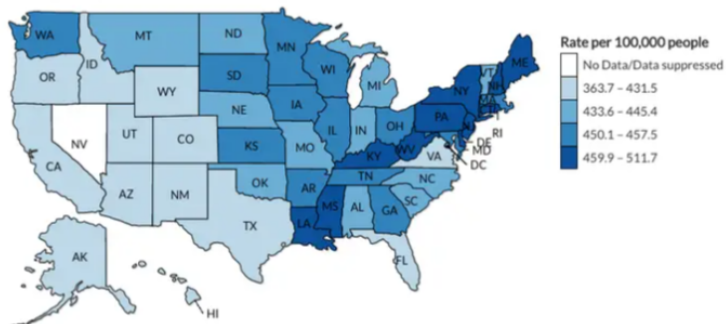
Days in 2024 predicted to have an average air quality index of 100 or higher under current climate conditions



Data: First Street Foundation; Note: Maximum count of days with unhealthy air quality from anywhere within each county; Map: Kavya Beheraj/Axios

Examples of spatial data - health

Rates of New Cancer Cases in the United States
All Types of Cancer, All Ages, All Races/Ethnicities, Both Sexes



[CDC.gov](https://www.cdc.gov)

Introduction

- ▶ Becoming an expert in spatial data analysis provides:
 - ▶ Access to interesting applications
 - ▶ Opportunity for methodological development
 - ▶ Opportunity for advancing computational tools

- ▶ This class provides tools to analyze spatial data and the background needed to begin research in this area

Types of spatial data

(1) Geostatistical (point-referenced) data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Types of spatial data

(2) Areal data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Types of spatial data

(3) Point pattern (point process) data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Types of geostatistical data

Spatiotemporal data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Types of geostatistical data

Multivariate data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Types of geostatistical data

Non-Gaussian data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Types of geostatistical data

Functional data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Types of geostatistical data

Extreme data

- ▶ Definition:
- ▶ Examples:
- ▶ Common objectives:

Inferential methods – Challenges

- ▶ Typically we only get one realization, so asymptotics are tricky

- ▶ A standard analysis of spatial data at n locations requires manipulating the $n \times n$ covariance matrix which is slow

Visualizing spatial data

- ▶ Getting to make pretty maps is one great feature of doing a spatial analysis!
- ▶ GIS makes the best maps
- ▶ We will use R
- ▶ Some common tools are given on the course website:

Plotting guidelines