

# Spatial Statistics in Epidemiology and Public Health

## Lecture 1: Introduction (You Are Here)

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# Welcome!

- ▶ Spatial Statistics in Epidemiology and Public Health
- ▶ Spatial statistics? In Epidemiology?
- ▶ *Where* something happens may offer insight into *what* is happening and *why*.
- ▶ Some ideas from statistics and epidemiology transfer over directly, some don't.
- ▶ We want *spatial* answers to spatial questions, and we want *statistical* answers to statistical questions.
- ▶ What do *spatial statistical* questions (and answers look like)?

# Course logistics

- ▶ Your instructors (both from Emory University):
  - ▶ Lance A. Waller
  - ▶ Howard Chang
- ▶ Framework: Modules and (short) labs in 90 minute blocks.
- ▶ Course materials on Github

# Monday schedule

- ▶ 9 - 10:30: Lectures 1 and 2: Introduction, GitHub Set Up, Maps, Mapping, GIS (Lance)  
10:30-11: Break
- ▶ 11-noon: Lecture 2: Maps, Mapping, Spatial Questions and Answers (Lance)  
Noon-1: Lunch (on your own)
- ▶ 1-3: Lecture 3: Area data (EDA, clustering) (Howard)  
3-3:30: Break
- ▶ 3:30-5: Lecture 4: Disease mapping (CAR, SAR) (Howard)
- ▶ 5-6:30pm: Networking night and poster session (R. Randall Rollins Room P01 – Plaza Level (Margaret H. Rollins Ballroom))

# Tuesday schedule

- ▶ 9 - 10:30: Lecture 5: Spatial regression and slippery slopes (Lance)  
10:30-11: Break
- ▶ 11-noon: Lecture 6: Gaussian processes (Howard)  
Noon-1: Lunch (on your own)
- ▶ 1-3: Lecture 7: Point processes (Lance)  
3-3:30: Break
- ▶ 3:30-5: Lecture 8: Space-time models (Howard)

# Wednesday schedule

- ▶ 9 - 10:30: Lecture 9: Disease ecology (Lance)  
10:30-11: Break
- ▶ 11-noon: Lecture 10: Multivariate processes (Howard)

# References: Spatial Statistics

- ▶ Waller, L.A. and Gotway, C.A. (2004) *Applied Spatial Statistics for Public Health Data*. Wiley.
- ▶ Lawson, A.B. (2023) *Using R for Bayesian Spatial and Spatio-Temporal Health Modeling*. CRC.
- ▶ Banerjee, S., Carlin, B.P, and Gelfand, A.E. (2015) *Hierarchical Modeling and Analysis for Spatial Data*. CRC.
- ▶ Blangiardo, M., Cameletti, M. (2015) *Spatial and Spatio-temporal Bayesian Models with R-INLA*. Wiley.
- ▶ Diggle, P.J., Giorgi, E. (2019) *Model-based Geostatistics for Global Public Health: Methods and Applications*. CRC.

# References: Mapping

- ▶ Monmonier, M. (2018) *How to Lie with Maps, Third Edition*. Chicagor.
- ▶ MacEachren, A. (1995) *How Maps Work*. Guilford.
- ▶ Koch, T. (2017) *Disease Maps*. Chicago.
- ▶ Koch, T. (2005) *Cartographies of Disease*. ESRI Press.
- ▶ Walker, K. (2023) *Analyzing U.S. Census Data: Methods, Maps, and Models in R*. CRC. Also available online at [walker-data.com/census-r/index.html](http://walker-data.com/census-r/index.html)
- ▶ Moraga P (2020) *Geospatial Health Data: Modeling and Visualization with R-INLA and Shiny*. Boca Raton: Chapman & Hall/CRC.
- ▶ Andrienko N et al. (2020) *Visual Analytics for Data Scientists*. Springer.
- ▶ Waller LA (2024) Maps: A statistical view. *Annual Review of Statistics and Its Applications*



# Scoping

- ▶ What spatial data do you work with?
- ▶ What spatial questions are of interest?

# Lectures and Labs and Course Materials

- ▶ Each session will have a lecture component and a (short) lab component.
- ▶ TA: Thomas Hsiao (thomas.hsiao@emory.edu)
- ▶ We created a Github repository for the course with all lecture notes, lab data, and lab Rmd (R markdown) files.
- ▶ There are pdf files of the lecture notes, there are pdf markdown files for the labs, and Rmd (R markdown) files for the labs.
- ▶ Go to <https://github.com/lance-waller-lab/2025-SISMID-Spatial-Statistics>

# Getting the files

- ▶ Go to the green “Code” button and download as a zip file.
- ▶ Save the zip file to a directory of your choice, then unzip the file. You will see a folder of lectures, a folder for data, etc.
- ▶ IMPORTANT: You will also see a file 2025-SISMID.Rproj this will pull in all of the lab code and data as a project.
- ▶ If you are unfamiliar with R/RStudio, you can focus on reading through the lab pdfs to see examples of what you can do.
- ▶ If you are familiar with R/RStudio, you can try out the Rmd code.

# Opening as an R Project in RStudio

- ▶ Open RStudio.
- ▶ Under the File menu, select “Open Project”.
- ▶ Navigate to the directory where you stored the downloaded folder.
- ▶ Open the 2025-SISMID.Rproj Rproject file.
- ▶ Under the 'Files' tab in the lower right quadrant of RStudio, you'll see folders for each of the lectures.
- ▶ Inside each of these folders will be the pdf and Rmd files for that lecture/lab combination.

# Some R notes

- ▶ R is a very popular, open-source environment, and there are many packages for different parts of spatial analysis.
- ▶ Some of the lab R code is based on old (in some cases, very old) packages but we have tested them for your use.
- ▶ There are many new packages for working with different types of data (e.g., geographic information system shapefiles).
- ▶ Walker (2023) gives a great entry for mapping and working with U.S. Census data: [walker-data.com/census-r/index.html](https://walker-data.com/census-r/index.html)
- ▶ Moraga (2020) provides illustrations of many mapping features and several mapping packages in R.
- ▶ Andrienko et al. (2020) gives some very nice data visualization advice for mapping (especially Chapters 9-10).

# A changing spatial geography: `sp` and `sf`

- ▶ <https://r-spatial.org/> provides the latest on setting standards for spatial data handling in R.
- ▶ `sp` is the former standard for spatial processing and many R functions relied on it.
- ▶ `sf` is the new standard (and is different from `sp`, but improved in many ways).
- ▶ There was a goal of independence from `sp` by October 2023, but there are some legacy packages supporting it and some old packages that require it.
- ▶ It is important to know this is going on when working in spatial statistics and using R.
- ▶ Some of the details are in the weeds, but they do influence the trees!

# Let's get the repositories set up

- ▶ Follow the directions above.
- ▶ Download the zip file.
- ▶ Unload the zip file.
- ▶ Open RStudio.
- ▶ Open the Project.
- ▶ Make sure you can open the Rmd files.

# Helpful References: Spatial Statistics

- ▶ Waller, L.A. and Gotway, C.A. (2004) *Applied Spatial Statistics for Public Health Data*. Wiley.
- ▶ Lawson, A.B. (2023) *Using R for Bayesian Spatial and Spatio-Temporal Health Modeling*. CRC.
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- ▶ Moraga P (2020) *Geospatial Health Data: Modeling and Visualization with R-INLA and Shiny*. Boca Raton: Chapman & Hall/CRC.
- ▶ Andrienko N et al. (2020) *Visual Analytics for Data Scientists*. Springer.
- ▶ Waller LA (2017) Mapping in Public Health. In *Mapping Across Academia*, Brunn, S.D. and Dodge, M., eds. Dordrecht: Springer.