Overview

Spatial analysis, broadly defined, is the study of the relationships between phenomena as a function of their positions and extents in two or more dimensions. When at least two of those dimensions correspond to the Earth’s surface, we are analyzing geographic information, the fundamental substrate of environmental science.

EDS 223 / ESM 267 takes a programming approach to geographic information: instead of using a geographic information system (GIS) application (e.g., ArcGIS; QGIS), we will be manipulating and analyzing geographic information by writing programs in R and Python. This approach gives you a deeper understanding of the underlying operations and data structures that support geographic information, and is also much more flexible in terms of the problems you can address—you’re not limited to the capabilities built into a particular GIS application.

learning objectives

This course aims to give you hands-on experience with:

- file formats and data models that programming environments use to store and represent geographic information;
spatial data structures and operations implemented by popular packages for R and Python;
programming geographic analyses in R and Python, as an alternative or complement to standalone GIS applications.

why 2 courses?

This quarter (Fall 2021) we are offering EDS 223 and ESM 267 as a single cross-listed course. This is admittedly an experiment, especially since it’s the first time we’ve taught 223. Our rationale for this is twofold:

1. EDS 223 is intended to be a “GIS-for-programmers” course, and ESM 267 has historically focused on scripting and programming GIS operations.
2. As one of the few points where the MEDS and MESM curricula overlap in both timing and content, a merged course offers an excellent opportunity for MEDS and MESM students to learn collaboratively.

teaming up

Broadly speaking, we expect the MEDS students will have fresher programming “chops” than the MESM students, whereas the MESM students will have more experience with geographic information. To leverage (as opposed to possibly disadvantage) these different backgrounds, we will (randomly) team up each MEDS student with at least one MESM student, and you’ll do the classwork together.

Your team assignments are here.

preparation

We assume the following preparation, depending on which program you’re enrolled in:

- EDS 223: the MEDS summer intensive courses
- ESM 267: ESM 206 (Statistics and Data Analysis), ESM 263 (Geographic Information Systems)

Administrivia

instructors

- professor: James Frew (frew@ucsb.edu)
  - office hours: by appointment; in Bren Hall 4524 or on Zoom
- teaching assistant: Niklas Griessbaum (griessbaum@ucsb.edu)
  - office hours: Thursdays 12:00 to 13:00 in Bren Hall 3001. Alternatively by appointment.
venues

- **class:** Fridays 09:00–12:00 in Bren Hall 1414
  - 09:00–10:15 lecture
  - 10:25–12:00 lab
  - no class on Friday 26 November (Thanksgiving holiday)

- **website:** You are here.

- **Slack channel:** Feel free to use this to communicate with each other about the course. We (Frew & Niklas) will monitor it when we can, but if you need to get our attention, please use email.

- **shared folder:** Read-only files used by assignments and exercises, and/or that are too big to upload to the course website.

course materials

- **Textbooks:** None. All materials are online, linked as appropriate to the syllabus, and are either freely available, or can be accessed via the UCSB VPN or Library proxy server.

  Note: We’ll refer to the following online books often enough that we’ve given them abbreviations:

  - GwR: Lovelace, R.; Nowosad, J.; Muenchow, J. (2091) *Geocomputation with R*.
  - SDSwaiR: Pebesma, E.; Bivand, R. (2021) *Spatial Data Science with applications in R*.

- **Computer:** You will be using your own computer in this course—be sure to bring it to each class, with a fully-charged battery.

- **Software:** You have 2 options for accessing the software necessary for this course. (Details will be provided in our first class.)
  
  - **local:** Install the standard MEDS software on your computer.
    - Note: You don’t need to install Docker for this course.
    - Additional R and Python packages specific to the course will be noted in the syllabus.
  
  - **remote:** Access the MEDS RStudio Workbench and JupyterHub servers from your web browser.

  (We recommend that you install the software locally, even if you plan primarily to use the MEDS servers, so that you have a backup option in case of network issues.)

Syllabus
The first half of the course will introduce GIS programming in R, roughly following the order in which topics are presented in ESM 263.

The second half of the course will introduce GIS programming in Python, by comparison with R, and focusing on applications like spatial databases and online GIS services.

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<th>week</th>
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<td>1</td>
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<td>• administriva</td>
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<td>• introduction to geographic data in R</td>
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<td>2</td>
<td>01 Oct</td>
<td>• maps and coordinate systems</td>
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<td>3</td>
<td>08 Oct</td>
<td>• spatial features and vector operations</td>
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<td>4</td>
<td>15 Oct</td>
<td>• spatial attributes and tables</td>
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<td>5</td>
<td>22 Oct</td>
<td>• spatial fields and raster operations</td>
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<td>6</td>
<td>29 Oct</td>
<td>• turning models into code</td>
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<td>7</td>
<td>05 Nov</td>
<td>• Python for GIS</td>
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<td>8</td>
<td>12 Nov</td>
<td>• Python: spatial databases</td>
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<td>9</td>
<td>19 Nov</td>
<td>• Python: online GIS services</td>
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<td>10</td>
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<td>• final project presentations</td>
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Assignments

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<td>3</td>
<td>Thu 04 Nov</td>
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<td>4</td>
<td>Thu 02 Dec</td>
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