Spatial Analysis and the Built Environment

VIS 2129

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Course meeting times: Mondays and Wednesdays, 8:30am to 10am.

(Virtual) course meeting location:
https://harvard.zoom.us/j/99659230894?pwd=SW5GVEMxa1liVW82enhJUzEyOEJkZz09

What will I learn in this class?
Planners today have access to unprecedented amounts of data on the built environment and the people who use it. These data come from a wide variety of sources ranging from traditional administrative data and survey data to emerging sources of passively-collected and crowdsourced data. My goal is for you to confidently navigate unfamiliar datasets and create information[3] that you can use to (1) improve your own understanding of places and spatial phenomena at the regional, neighborhood, and site scales and (2) communicate your ideas and conclusions to others. You will learn to create figures and maps that are appropriate for inclusion in reports, posters, and web-based presentations. This course emphasizes iteration and creativity, and I have designed the assignments and in-class exercises to help you discover what works through experimentation.

What books and materials do I need to purchase for this class? What other additional costs will there be beyond tuition?
None. All materials you need for this course are either freely available online or freely available to you through the library.

How should I prepare for lectures?
I've designated a reading assignment or a creative assignment that you should complete before each lecture. Table 1 shows the scheduled topics and assignments for each lecture. Appendix A includes more details on the specific learning objectives of each lecture. Appendix B includes details on each reading assignment. Appendix C includes details on each creative assignment. For reading assignments, come

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[1] Email will usually be the best way to ask me relatively simple, non-urgent questions, and I will do my best to respond to emails within two business days.

[2] You are welcome to call or text me if you need a response right away. I can think of very few likely circumstances (not resulting from procrastination or poor planning) where this would be necessary, but that's the nature of emergencies: they're unexpected. I don't typically answer phone calls from numbers I don't recognize, so texting is likely to get you a faster response.

[3] I find it helpful to differentiate between data and information. Data numbers words, images, and sounds that are not useful without some kind of analysis, visualization, or post-processing. The output of that analysis is information you can use to form conclusions and make decisions.

prepared to offer questions and comments about what you read. For creative assignments, you should be prepared to share your work and receive feedback from me and from your classmates.

Table 1: Lecture topics and assignments

Week	Date	Topic	Assignment
1	Wednesday, September 2	Course introduction	Course syllabus
	Monday, September 7	Labor Day (no class)	
2	Wednesday, September 9	Relationships and distributions	Reading Assignment 1
	Monday, September 14	Relationships and distributions	Creative Assignment 1 (draft)
3	Wednesday, September 16	Coordinate systems	Creative Assignment 1 (final) Reading Assignment 2
	Monday, September 21	Coordinate systems	Creative Assignment 2 (draft)
4	Wednesday, September 23	Areas and locations	Creative Assignment 2 (final) Reading Assignment 3
	Monday, September 28	Areas and locations	Creative Assignment 3 (draft)
5	Wednesday, September 30	Lines and networks	Creative Assignment 3 (final) Reading Assignment 4
	Monday, October 5	Lines and networks	Creative Assignment 4 (draft)
6	Wednesday, October 7	Identity, bias, and objectivity	Creative Assignment 4 (final) Reading Assignment 5
	Monday, October 12	No class (Indigenous People's Day)	
7	Wednesday, October 14	Participatory mapping	Reading Assignment 6
	Monday, October 19	Participatory mapping	Creative Assignment 5 (draft)
8	Wednesday, October 21	Interactive maps	Creative Assignment 5 (final) Reading Assignment 7
	Monday, October 26	Interactive maps	Creative Assignment 6 (draft)
9	Wednesday, October 28	Raster interpolation	Creative Assignment 6 (final)
	Monday, November 2	Raster interpolation	Creative Assignment 7 (draft)
10	Wednesday, November 4 Class will begin at 9:30am	Site-level visualization (2D)	Creative Assignment 7 (final)
	Monday, November 9	Site-level visualization (2D)	Creative Assignment 8 (draft)
11	Wednesday, November 11	Site-level visualization (3D)	Creative Assignment 8 (final) Reading Assignment 9
	Monday, November 16	Site-level visualization (3D)	Creative Assignment 9 (draft)
12	Wednesday, November 18	Graphic design principles	Creative Assignment 9 (final) Reading Assignment 10
	Monday, November 23	Graphic design principles	Early portfolio draft
13	Wednesday, November 25	Thanksgiving break (no class)	
	Monday, November 30	Oral presentation	Reading Assignment 11
14	Wednesday, December 2	Course overview	Final portfolio

What will happen during scheduled lectures (synchronous content)?
Our lectures will take place on Mondays and Wednesdays from 8:30am to 10am. In general, I will introduce material on Wednesdays. The following Monday, you will come to class having made substantial progress on an assignment related to the topic we discussed the previous Wednesday.

A typical Wednesday session will generally unfold as follows:

- **8:40am – 9:00am:** Discussion of the reading assignment
- **9:00am – 9:30am:** In-class exercise (as much as possible, these are designed to be done individually and away from your computer)
- **9:30am – 10am:** Discussion of in-class exercise

A typical Monday session will generally unfold as follows:

- **8:40am – 9:10am: Very small group discussions of assignments.** You will have this time to discuss your work in a group of no more than two or three other students. Occasionally, Carole, Alex, or Taelor will join your group for this discussion.
- **9:15am – 9:45am: Small group presentations of assignments.** In groups of ten, you will hear three of your classmates present their assignment for the week, and you will have time to ask questions and offer feedback. Carole, Alex, or Taelor will usually join for all or part of these presentations.
- **9:45am – 10am: Full class discussion of assignment.** We will meet as a full class to discuss major takeaways and lessons learned from the week's assignment.

What are your expectations for participating in lectures via Zoom?
These are more preferences than expectations. My highest priority is that you are able to fully engage in our class discussions

1. If you're in group of more than five or so people (e.g. a lecture with the full class or a large breakout room), keep your microphone muted when you aren't speaking. In small breakout rooms, I don't think it matters, unless you're in a place with a lot of background noise (and I've found that you can generally get away with more background noise than you might think before it becomes audible to other Zoom meeting participants).
2. I don't mind if you keep your camera turned off - there are lots of good reasons why you might prefer/need to keep it off. Having said that, it's helpful to me if at least some class members have their cameras on during lectures so that I don't feel like I'm talking to an empty void.
3. Likewise, if you are joining from a location where it isn't practical to speak out loud (for example, if you work in a room where others are sleeping), you are always welcome to participate in class discussion, including small-group discussions, using the chat window in Zoom.
4. It's helpful to me if your display name reflects the name I should call you. Likewise, it's helpful if you can indicate in your display name which pronouns I should use to refer to you (even if you think your pronouns and/or gender are obvious). However, this is not a requirement.

What will I be doing outside of class (asynchronous content)?
Outside of class, you will complete weekly reading assignments and creative assignments. I have created tutorials, including some video tutorials, here to assist you in completing these assignments.

What software will I learn in this class?
The focus of this class is on the choices you'll make while designing spatial data visualizations, rather than on any particular software, so I've tried to develop the lectures to be relatively software agnostic. Having said that, it will be easiest to collaborate if we are all using the same tools, so I'll ask you to do most of your creative assignments using some combination of R[4], ArcGIS (or QGIS[5]), and Adobe Creative Suite. I assume many if not most of you have had limited experience with these programs, so we will hold Friday

[4] R is a free and open-source programming language and environment. RStudio is a free, open-source user interface for R that makes programming in R a lot easier. Much of the analysis and visualization work we'll be doing in R can also be done in Python. If you have prior experience in Python, you might choose to complete some of the creative assignments in Python, but I'm not a Python user myself, and I won't be able to offer much support. I'm not going to weigh in on which language is better. R is more commonly used in the social sciences, and was originally developed for statistical analysis; Python is a more general-purpose coding language that has become very popular with data scientists. Once you've learned to code in one language, it's not that hard to pick up another (said the professor who has yet to take the time to learn Python).

[5] QGIS is free and open source geographic information system (GIS) software. Most of the mapping exercises in this class will be done in R, but there will be some where you will find ArcGIS or QGIS to be helpful.

Software Workshops to introduce you to the skills you will need to complete all the assignments for this class. Friday Software Workshop topics are listed in Table 2.

These sessions will take place at the following Zoom link:
https://harvard.zoom.us/j/92537640098?pwd=NUs3aFdrN0hnUFB5dnBDOWdNUWF2QT09

Table 2: Friday Software Workshops

Date	Topic
September 4	Introduction R and GitHub
September 11	ggthemes and color palettes
September 18	Rmarkdown and Rmarkdown themes
September 25	R and GIS to Illustrator Workflows
October 2	Open Street Maps and Open Trip Planner in R
October 9	The raster package in R
October 16	TBD
October 23	Georeferencing in ArcGIS and QGIS
October 30	Google Sketchup
November 6	Leaflet in R
November 13	Photoshop collage
November 20	Open

How will you determine my grade in this class?
To pass this class, you need earn at least 60 percent of available points (see below for the breakdown of how points are distributed). Most of you will receive a Pass grade in this class. One or two students with the highest scores in class may receive a Pass with Distinction, and students with grades in the top 20 percentile or so will receive a High Pass. Students who earn between 60 and 70 percent of available points will receive a Low Pass. Midway through the semester, if it looks like you're not on track to pass this class, or if you're on track to receive a Low Pass, I will send you a midterm warning letter, and we'll meet to discuss what you can do to change your trajectory.

Participation in lectures (10% of your grade): You can earn up to five points for your participation in each lecture, based on the following scale:

- 5 points: You completed the (reading or creative) assignment before class and came to class prepared to discuss it.
- 3 points: You attended class, but did not come prepared to discuss the assignment.
- 1 point: You completed the day's creative assignment before class, but did not attend class.

Creative assignments (70% of your grade): You'll complete ten creative assignments over the course of the semester. Details on each assignment are included in Appendix C.

Final portfolio (20% of your grade): You will generate several maps and figures for each creative assignment. At the end of the semester, you will select (and probably revise) your ten favorite figures and compile them into a final portfolio.

What will happen if I submit a creative assignment late?
As soon as you realize you won't be able to submit a creative assignment before the deadline (even if you don't realize this until moments before the deadline), send me an email that includes the following information:

1. The reason your assignment will be late, and
2. The date by which you will submit the assignment.

As long as you email me before the deadline, I will accept late assignments by your proposed deadline with the following penalties:

- First late assignment: No grade reduction (other than lost participation points)
- Second late assignment: 10 percent grade reduction (in addition to lost participation points)
- Subsequent late assignments: 50 percent grade reduction (in addition to lost participation points)

If you do not email me in advance of a deadline, I'll make decisions on a case-by-case basis about whether to accept late assignments and what the appropriate grade reduction should be. I understand that sometimes the reason that your assignment will be late is also the reason you can't email me ahead of time.[6]

Is it okay for me to submit someone else's work and present it as my own?
No, that's plagiarism, and it's totally unacceptable. Having said that, I strongly encourage you to work collaboratively on all your assignments. If portions of your work are copied from or inspired by your classmates or others, just include some kind of citation or attribution statement in your submittal.

What should I do if I think my online participation in this course puts me at risk?
Above all, I want all of you to feel safe participating in class. This is also a priority of the GSD administration, and they have asked all faculty to include this statement in each course syllabus:

> Virtual participation poses risks for GSD students from certain countries, especially as many of them will be living in those countries for the duration of this GSD course and thus will be more vulnerable than usual. Class members concerned about participation in particular sessions must contact the instructor in advance of class and request that they be allowed to keep their video turned off, participate via the Zoom 'chat' function directly with the instructor, participate in the class in written form or request through an application process run by GSD Student Services (*lsnowdon@gsd.harvard.edu*) 'special status' for this course which will confer the right upon a class member to not participate in certain classes without fear of grade consequences. For further details see the Appendix titled- 'Participation and Risk in Virtual Classes' prepared by the University located on the course Canvas site.

I'll add that I have designed this course with the intention of creating a virtual space in which everyone feels valued, included, and safe. I recognize that you may have individual circumstances that result in some aspects of this course being uniquely burdensome or risky for you in ways that I failed to consider when I designed the course. If this is the case, I am eager to hear from you so we can work together to find a solution that meets your needs.

Some people in this class are different from me. Is it okay for me to treat them disrespectfully?
Absolutely not. You are training to be planners, and that role will require you to understand and address the needs of diverse communities. That will require you to engage with people whose perspectives and life experiences are different from yours. Those diverse perspectives might relate to differences in race, ethnicity, sexual orientation, gender identity/expression, religion, nationality, political beliefs, or other personal characteristics. Everyone in this class deserves to be treated with civility and respect.

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[6] For example –and this is a true story– one morning when I was in grad school, I was in the bathroom at my home getting ready for my day, and my cat knocked over a bag of golf clubs that happened to be leaned against a wall near the bathroom door. The golf clubs fell against the door and wedged it tightly shut, and I was trapped in there for six hours until my spouse returned home. It was both incredibly stressful and incredibly boring. I did not have my phone or computer in the bathroom with me, so I missed all the meetings and deadlines I had that day, with no way of notifying anyone. So I understand that these kinds of unexpected things can happen.

What if someone in this class has made me feel like I don't belong here?
You *do* belong here, and I'm glad you're here. Please reach out to me if your classmates' behavior or (especially) if my own behavior is contributing to a classroom environment in which you do not feel welcome and included. If you are uncomfortable approaching me about our class environment, you can also reach out to Ann Forsyth (Director of the MUP Program) or Laura Snowdon (GSD Dean of Students).

How will this course respond to systemic racism?
We will address the topic of systemic racism in a few different lectures in this course.

In Week 6, we will discuss the degree to which people tend to overestimate how similar the needs and preferences of the "general population" are to their own and how collecting and reporting data that is disaggregated by sex, race, or other characteristics can reveal important sources of inequality.

In Week 7, we will extend this discussion consider to the limits of professional expertise compared to local expertise, and we will problematize reliance on professional expertise, particularly when a profession is not representative of the populations it serves.

In Week 11, we will describe how site-level representations of projects and proposals, particularly when they include images of people, can serve to exclude and marginalize particular populations, to present a false image of diversity and inclusivity, or to reinforce an unjust status quo.

How will this course respond to climate change?
In Week 10, we will discuss the persuasive power of interactive maps, using a study on the effectiveness of interactive maps in changing peoples' perspectives on climate change as an example.

Do I need to sacrifice my physical, mental, or emotional health to be successful in grad school?
Not at all! I hope you will prioritize your health and well-being for its own sake, and your academic performance will benefit when you do.

- Sleep for 7 to 9 hours each night.
- Drink about two liters (or 64 ounces) of water each day.
- Eat a balanced diet that includes lots of fresh fruit and vegetables.
- Aim for at least 20 or 30 minutes of moderate physical activity each day.
- If you have religious or spiritual practices that are meaningful to you, continue them during your time in grad school.
- Find time to connect with friends and loved ones on a regular basis, including your classmates here, many of whom I hope will become lifelong friends.
- Familiarize yourself with resources and services offered by Harvard University Health Services Counseling and Mental Health Services by visiting https://camhs.huhs.harvard.edu/. This will prepare you to avail yourself of these resources at times when they could be helpful, and to recommend them to friends who might benefit.

Appendix A: Lecture learning outcomes

Week 1: Course introduction

Learning outcome A: Identify ten different visual cues (position, length, angle, direction, area, volume, saturation, hue, shape, and time) for representing spatial data and rank them in the approximate order of how accurately people perceive them.

Learning outcome B: Create conceptual designs for graphics that represent spatial data by using various combinations of visual cues

Week 2: Relationships and distributions

Learning outcome A: Create figures to represent the distributions single categorical or continuous variables using histograms, density curves, violin plots, box plots, bar charts, pie charts, and other techniques.

Learning outcome B: Create figures to represent relationships between multiple continuous or categorical variables using scatter plots, trend lines, and other techniques.

Learning outcome C: Select an appropriate scale (logarithmic or linear) and coordinate system (Cartesian or polar) coordinate system for displaying data

Week 3: Projections and distortions

Learning outcome A: Create a map to show spatial data using an appropriate map projection.

Learning outcome B: Convert between projected and geographic coordinate systems.

Learning outcome B: Use map distortions to communicate information places.

Week 4: Areas and locations

Learning outcome A: Quantify relationships among locations that can be described as points and polygons on a map.

Learning outcome B: Create a map showing relationships between points and polygons using buffers and spatial joins.

Week 5: Lines and networks

Learning outcome A: Calculate network characteristics in terms of nodes, links, centrality, and distance.

Learning outcome B: Represent physical networks and their characteristics on a map.

Week 6: Identity, bias, and objectivity

Learning outcome A: Explain why relationships that are true of population groups are not necessarily true of individual members of those groups (the ecological fallacy).

Learning outcome B: Describe hierarchal geographic census units, including regions, states, counties, tracts, block groups, and blocks, as well as non-hierarchal units, including census-designated places, metropolitan statistical areas, and public use microdata areas.

Learning outcome C: Select an appropriate geographic unit of analysis to address a particular research question and describe how alternative units of analysis could lead to different conclusions (the modifiable areal unit problem).

Week 8: Participatory Mapping

Learning outcome A: Identify types of spatial knowledge that may not be reflected in official, technical data sources.

Learning outcome B: Georeference an image for use in a geographic information system.

Week 7: Participatory Mapping
Learning outcome A: Identify types of spatial knowledge that may not be reflected in official, technical data sources.

Learning outcome B: Georeference an image for use in a geographic information system.

Week 8: Interactive maps
Learning outcome A: Describe how allowing a user autonomy in how data is displayed can contribute to the persuasive power of a map or figure.

Learning outcome B: Create a web-based interactive map.

Learning outcome C: Describe how the design of a map or figure can shift the balance of power between the designer and the user.

Week 9: Raster data (interpolation)
Learning outcome A: Interpolate a continuous surface from values observed at discrete points in space.

Learning outcome B: Create a map that uses a raster layer to represent the spatial variation of a continuous variable.

Week 10: Visualizing site (2D)
Learning outcome A: Describe how decisions about how to visualize a site can shape perspectives about the site.

Learning outcome B: Create a collage visualization of a planned site-level improvement.

Week 11: Visualizing site (3D)
Learning outcome A: Create a 3D model of a planned site-level improvement.

Learning outcome B: Transform an image (scale, shear, and rotation) from a plan view to an axonometric view.

Week 12: Graphic design principles
Learning outcome A: Design a report page layout that uses contrast, repetition, alignment, and proximity to engage the reader.

Learning outcome B: Design a poster (board) layout that uses contrast, repetition, alignment, and proximity to engage the audience.

Learning outcome C: Design a web page layout that uses contrast, repetition, alignment, and proximity to engage the user.

Week 13: Oral presentation of graphical content
Learning outcome A: Find an authentic speaking style that works for you by experimenting with your speaking pace, volume, rhythm, and reliance on notes.

Learning outcome B: Create a narrative structure for a slide-based oral presentation.

Learning outcome C: Create engaging slides to complement an oral presentation

Appendix B: Reading Assignments

I expect you to complete required readings before the class they correspond to (refer to Table 1). You also should glance through the optional readings so you know what they're about. You might choose to the read them if you're interested, and you might refer back to them as references.

Reading Assignment 1: Relationships and distributions

Required reading: *Data Points*, Chapter 3,
Data Points, Chapter 4, Visualizing Categorical Data, Visualizing Time Series Data, Multiple Variables, and Distributions.

Reading Assignment 2: Projections and distortions

Required reading: *Understanding Map Projections*, Chapters 1 and 2

Optional reading: Cartographic Projection

Reading Assignment 3: Areas and locations (points and polygons)

Required reading: *Data Points*, Chapter 4: Visualizing Spatial Data
How to Lie with Maps, Chapters 5 and 11

Reading Assignment 4: Lines and networks

Required reading: *A multi-scale analysis of 27,000 urban street networks*

Reading Assignment 5: Identity, bias, and objectivity

Required reading: The Historical Role of Race and Policy for Regional Inequality
I'm Multimodal, Aren't You? How Ego-Centric Anchoring Biases Experts' Perceptions of Travel Patterns
Invisible Women, Chapter 1

Optional reading: Red State, Blue State, Rich State, Poor State, Chapters, 1, 2, and 3.
Geographic Areas Reference Manual, Chapter 2

Reading Assignment 6: Participatory Mapping

Required reading: Good Practices in Participatory Mapping

Reading Assignment 7: Interactive maps

Required reading: Understanding Local Sea Level Rise Risk Perceptions and the Power of Maps to Change Them: The Effects of Distance and Doubt

Reading Assignment 8: Raster data (interpolation)

Required reading: Intro to GIS and Spatial Analysis, Chapters 13 and 14.

Reading Assignment 9: Sites

Required reading: Why the scale figures in architectural images need to be more diverse

Reading Assignment 10: Graphic design principles

Required reading: *The Non-designer's Design Book*, Chapters 1 and 6.

Optional reading: Land-based Classification Standards
Experimenting with planning color standards

Reading Assignment 11: Oral Presentation of graphical content

Required reading: TED Talks: The Official TED Guide to Public Speaking, Chapters 11 and 17

Optional reading: TED Talks: The Official TED Guide to Public Speaking (the rest of the book)

Appendix C: Creative Assignments

Unless otherwise noted, all assignments should be submitted as html files (knitted RMarkdown documents) that show the code you used to create the figures.

Creative Assignment 1: Relationships and distributions (due before class on September 16 – please come to class on September 14 having made substantial progress)

Create or find a dataset with at least to categorical variables and at least two continuous variables. Illustrate the distributions of your selected variables and the relationships among them by creating at least ten different figures, none of which should be maps. It's okay if some of your figures are terrible, but they should be as different from each other as possible. Experiment with different coordinate systems, scales, aesthetics, and geometries.

Creative Assignment 2: Projections and distortions (due before class on September 23 – please come to class on September 21 having made substantial progress)

Select a large area from Table C-1 below, and create a map of the area, with its associated subareas, using each of three different map projections. Indicate the map projection you've used for each. Identify a variable and use at least three different methods to show how it varies among the subareas.

Table C-1: Large areas that may be used for Creative Assignment 1, with associated subareas

Large area	Subareas
Africa	Countries
China	Provinces
Europe	Countries
India	States
South America	Countries
United States of America	States (you may or may not exclude Alaska and Hawaii)

Creative Assignment 3: Areas and locations (points/polygons) (due before class on September 30 – please come to class on September 28 having made substantial progress))

Identify a municipal open data portal and find two point layers (A and B) and two polygon layers (C and D).

Calculate six of the following 22 possible metrics, and illustrate the results of each calculation with a map. Each of the four layers you selected should appear in at least one of those six maps.

1. The number and proportion of A points within a specified distance of B points.
2. The number and proportion of B points with a specified distance of A points.
3. The average (Euclidean) distance between A points and their nearest respective B points.
4. The average (Euclidean) distance between B points and their nearest respective A points.
5. The number and proportion of A points within C polygons.
6. The number and proportion of A points within D polygons.
7. The number and proportion of B points within C polygons.
8. The number and proportion of B points within D polygons.
9. The number and proportion of C polygons containing A points.
10. The number and proportion of D polygons containing A points.
11. The number and proportion of C polygons containing B points.
12. The number and proportion of D polygons containing B points.
13. The number and proportion of C polygons that overlap with D polygons.
14. The number and proportion of D polygons that overlap with C polygons.
15. The average number of A points in each C polygon.

16. The average number of A points in each D polygon.
17. The average number of B points in each C polygon.
18. The average number of B points in each D polygon.
19. The average density of A points in each C polygon.
20. The average density of A points in each D polygon.
21. The average density of B points in each C polygon.
22. The average density of B points in each D polygon.

Creative Assignment 4: Lines and networks (due before class on October 7 – please come to class on October 5 having made substantial progress)
Select between five and 30 locations within a city or metropolitan area. For each location, generate isochrones for the same travel time for at least two different modes. Calculate the area of each isochrone and compare the areas of the isochrones for the two (or more) modes you analyzed. Create three figures (which may or may not be maps) to illustrate the results of your analysis.

Creative Assignment 5: Georeferencing images
Create a hand-drawn map of a neighborhood you have spent a lot of time in, including annotations to indicate locations that are meaningful to you. Digitize your drawing and georeference the image using GIS software. Create three different maps with at least two layers each, where one layer is your hand-drawn image and the other layer comes from another source (for example, streets, parcel boundaries, trees, or buildings footprints) superimposed on your drawing. ****This assignment should be submitted as a PDF document****

Creative Assignment 6: Interactive maps
Create an interactive map of a neighborhood that shows the locations of particular amenity, where users can pan, zoom, and click on an amenity to display more information about it. ****This assignment should be submitted as an html file that only includes the map. It does not need to be and RMarkdown file and does not need to display the code used to generate the map.****

Creative Assignment 7: Raster data (Interpolation)
Identify an area-level data set for a single variable (might be at the neighborhood level, zip-code level, or county-level, for example) that includes at least ten different zones. Show the variable in that variable by zone (as a chloropleth map), as points (using area centroids), and as a continuous surface (interpolating between centroid points. Your submission should include a discussion of which of these three methods is (a) most informative, (b) most interesting, (c) most appropriate to the data, and (d) best.

Creative Assignment 8: Site-scale visualization (2D)
Select a specific site (such as a single property, parcel, intersection, or street segment) and propose a physical improvement (such as building, a parklet, a revised lane configuration, or an art installation). Create two very different eye-level collages to illustrate what the site might look like after your plan is implemented. Incorporate both visualizations into a single layout, and include comments on how the overall effect of the two visualizations differ. ****This assignment should be submitted as a PDF document****

Creative Assignment 9: Site-scale visualization (3D)
Select a specific site (such as a single property, parcel, intersection, or street segment) and propose a physical improvement (such as building, a parklet, a revised lane configuration, or an art installation). Create two very different visualizations to illustrate what the site might look like after your plan is implemented, each of which incorporates a different view of a 3D model (for example, one created in Sketch-up). You may choose to use collage to further edit your images. Incorporate both visualizations into a single layout, and include comments on how the overall effect of the two visualizations differ. ****This assignment should be submitted as a PDF document****