

# PS4 v1.2: Spatial

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2024-10-30

**PS4:** Due Sat Nov 2 at 5:00PM Central. Worth 100 points.

We use (\*) to indicate a problem that we think might be time consuming.

## Version changes

(v1.2 10/30: Updated wording in Effects of Closure question question 1: from “Display a table of the number of zip codes vs. the number of closures they experienced” to “Display a table of the number of closures by zipcode”)

(v1.1 10/29: In “Calculate zip code’s distance to the nearest hospital”, we simplified 2. You no longer have to create a function to see if the polygons intersect. In “Calculate zip code’s distance to the nearest hospital”, we eliminated 4a. You no longer have to time the join of the subset first.)

## Style Points (10 pts)

Please refer to the minilesson on code style [here](#).

## Submission Steps (10 pts)

1. This problem set is a paired problem set.
2. Play paper, scissors, rock to determine who goes first. Call that person *Partner 1*.
  - Partner 1 (name and cnet ID):
  - Partner 2 (name and cnet ID):
3. Partner 1 will accept the **ps4** and then share the link it creates with their partner. You can only share it with one partner so you will not be able to change it after your partner has accepted.
4. “This submission is our work alone and complies with the 30538 integrity policy.” Add your initials to indicate your agreement: \*\* \_\_\_\_ \*\* \*\* \_\_\_\_ \*\*

5. “I have uploaded the names of anyone else other than my partner and I worked with on the problem set [here](#)” (1 point)
6. Late coins used this pset: `**__**` Late coins left after submission: `**__**`
7. Knit your `ps4.qmd` to an PDF file to make `ps4.pdf`,
  - The PDF should not be more than 25 pages. Use `head()` and re-size figures when appropriate.
8. (Partner 1): push `ps4.qmd` and `ps4.pdf` to your github repo.
9. (Partner 1): submit `ps4.pdf` via Gradescope. Add your partner on Gradescope.
10. (Partner 1): tag your submission in Gradescope

**Important:** Repositories are for tracking code. **Do not commit the data or shapefiles to your repo.** The best way to do this is with `.gitignore`, which we have covered in class. If you do accidentally commit the data, Github has a [guide](#). The best course of action depends on whether you have pushed yet. This also means that both partners will have to download the initial raw data and any data cleaning code will need to be re-run on both partners’ computers.

## Policy Background

Hospital closures have been on the rise in recent years. A hospital closure can have significant public health implications as they can increase travel distances for patients and reduce access to critical care, especially for already-vulnerable populations. Before starting, please read this issue brief from the Kaiser Family Foundation ([link](#)) to understand the broader social and policy context. We will first look at closures nationally and then focus on Texas, a state with large urban metro areas but also with a substantial share of population living in relatively remote rural areas.

## Download and explore the Provider of Services (POS) file (10 pts)

This file records all providers certified to bill Medicare and Medicaid. Each provider has a unique CMS certification number, consistent across different years.

- First download the Provider of Services (POS) file for Q4 2016.
  - Data: [data.cms.gov](https://data.cms.gov) ([link](#))
  - The data dictionary is located at the bottom of the page as “Provider of Services File - Hospital & Non-Hospital Facilities Data Dictionary”
- 1. (Partner 1) This is a fairly large dataset and we won’t be using most of the variables. Read through the rest of the problem set and look through the data dictionary to identify which variables you will need to complete the exercise, and use the tool on [data.cms.gov](https://data.cms.gov) into restrict to those variables (“Manage Columns”) before exporting (“Export”). Download this for 2016 and call it `pos2016.csv`. What are the variables you pulled?

2. (Partner 1) Import your `pos2016.csv` file. We want to focus on short-term hospitals. These are identified as facilities with provider type code 01 and subtype code 01. Subset your data to these facilities.
  - a. How many hospitals are reported in this data? Does this number make sense?
  - b. Cross-reference with other sources and cite the number you compared it to. If it differs, why do you think it could differ?
3. (Partner 1) Repeat the previous 3 steps with 2017Q4, 2018Q4, and 2019Q4 and then append them together. Plot the number of *observations* in your dataset by year.
4. (Partner 1) Each hospital is identified by its CMS certification number.
  - a. Plot the number of *unique hospitals* in your dataset per year.
  - b. Compare this to your plot in the previous step. What does this tell you about the structure of the data?

## Identify hospital closures in POS file (15 pts) (\*)

We will now use the 2016-2019 files to identify hospital closures nationally. A hospital is suspected to have closed if its Termination Code in the POS file lists them as an “Active Provider” in 2016 and then they are either not active or do not appear in the data at all in a subsequent year.

1. (Partner 2) Use this definition to create a list of all hospitals that were active in 2016 that were suspected to have closed by 2019. Record the facility name and zip of each hospital as well as the year of suspected closure (when they become terminated or disappear from the data). How many hospitals are there that fit this definition?
2. (Partner 2) Sort this list of hospitals by name and report the names and year of suspected closure for the first 10 rows.
3. (Partner 2) However, not all suspected hospital closures are true closures. For example, in the case of a merger, a CMS certification number will appear to be “terminated,” but then the hospital re-appear under a similar name/address with a new CMS certification number in the next year. As a first pass to address this, remove any suspected hospital closures that are in zip codes where the number of active hospitals does not decrease in the year after the suspected closure.
  - a. Among the suspected closures, how many hospitals fit this definition of potentially being a merger/acquisition?
  - b. After correcting for this, how many hospitals do you have left?
  - c. Sort this list of corrected hospital closures by name and report the first 10 rows.

## Download Census zip code shapefile (10 pts)

Navigate to the [Census shapefiles \(link\)](#), select “gz\_2010\_us\_860\_00\_500k.zip” and download the resulting shapefile.

*Note: If you have difficulty downloading or working with the file because the size is too large for your computer, reach out to the instruction team on Ed so that we can give them a smaller initial shapefile to work with.*

1. (Partner 1) This is non-tabular data. 1a. What are the five file types and what type of information is in each file? 1b. It will be useful going forward to have a sense going forward of which files are big versus small. After unzipping, how big is each of the datasets?
2. (Partner 1) Load the zip code shapefile and *restrict to Texas zip codes*. (Hint: you can identify which state a zip code is in using the first 2-3 numbers in the zip code ([Wikipedia link](#))). Then calculate the number of hospitals per zip code in 2016 based on the cleaned POS file from the previous step. Plot a choropleth of the number of hospitals by zip code in Texas.

## Calculate zip code’s distance to the nearest hospital (20 pts) (\*)

1. (Partner 2) Create a GeoDataFrame for the centroid of each zip code nationally: `zips_all_centroids`. What are the dimensions of the resulting GeoDataFrame and what do each of the columns mean?
2. (Partner 2) Create two GeoDataFrames as subsets of `zips_all_centroids`. First, create all zip codes in Texas: `zips_texas_centroids`. Then, create all zip codes in Texas *or* a bordering state: `zips_texas_borderstates_centroids`, using the zip code prefixes to make these subsets. How many unique zip codes are in each of these subsets?
3. (Partner 2) Then create a subset of `zips_texas_borderstates_centroids` that contains only the zip codes with at least 1 hospital in 2016. Call the resulting GeoDataFrame `zips_withhospital_centroids` What kind of merge did you decide to do, and what variable are you merging on?
4. (Partner 2) For each zip code in `zips_texas_centroids`, calculate the distance to the nearest zip code with at least one hospital in `zips_withhospital_centroids`.
  - a. This is a computationally-intensive join. Before attempting to do the entire join, subset to *10 zip codes* in `zips_texas_centroids` and try the join. How long did it take? Approximately how long do you estimate the entire procedure will take?
  - b. Now try doing the full calculation and time how long it takes. How close is it to your estimation?

- c. Look into the .prj file and report which unit it is in. Convert the given unit to miles, using an appropriate conversion you find online (estimates are okay).
5. (Partner 2) Calculate the average distance to the nearest hospital for each zip code in Texas.
  - a. What unit is this in?
  - b. Report the average distance in miles. Does this value make sense?
  - c. Map the value for each zip code.

## **Effects of closures on access in Texas (15 pts)**

1. (Partner 1) Using the corrected hospital closures dataset from the first section, create a list of directly affected zip codes in Texas – that is, those with at least one closure in 2016-2019. Display a table of the number of closures by zipcode
2. (Partner 1) Plot a choropleth of which Texas zip codes were directly affected by a closure in 2016-2019 – there was at least one closure within the zip code. How many directly affected zip codes are there in Texas?
3. (Partner 1) Then identify all the indirectly affected zip codes: Texas zip codes within a 10-mile radius of the directly affected zip codes. To do so, first create a GeoDataFrame of the directly affected zip codes. Then create a 10-mile buffer around them. Then, do a spatial join with the overall Texas zip code shapefile. How many indirectly affected zip codes are there in Texas?
4. (Partner 1) Make a choropleth plot of the Texas zip codes with a different color for each of the 3 categories: directly affected by a closure, within 10 miles of closure but not directly affected, or not affected.

## **Reflecting on the exercise (10 pts)**

- (Partner 1) The “first-pass” method we’re using to address incorrectly identified closures in the data is imperfect. Can you think of some potential issues that could arise still and ways to do a better job at confirming hospital closures?
- (Partner 2) Consider the way we are identifying zip codes affected by closures. How well does this reflect changes in zip-code-level access to hospitals? Can you think of some ways to improve this measure?