

Where in the USA is Carmen Sandiego?

A United States Geography Interactive Question and Answer Game

Abstract

Carmen Sandiego is a professionally trained criminal mastermind who is working as a double agent to help the Agency to Classify & Monitor Evildoers (ACME) stop the Villains International League of Evil's (VILE) thieving streak. VILE is as red-hot on Carmen's trail as her trench coat and she needs a quick place to hide. You suggest a quick hiding spot somewhere in the United States of America. You call ACME to report Carmen Sandiego's location, but VILE is closing in fast.

Thankfully VILE is better at stealing than at deciphering riddles or geography, so you proceed to report her location via text. While running from VILE, ACME asks you easy to answer questions to try to narrow down your hiding spot for Carmen. Your cell is dying and only has only enough battery for 20 questions. If ACME cannot locate her before VILE... well let's not think about that. Questions including coast lines, populations, and more await you. Answer truthfully, or the ACME extraction team will not stand a chance of finding the red-headed Carmen Sandiego before VILE does. The information that Carmen has can stop VILE forever, and they want nothing more than to stop her themselves to keep ACME from acquiring the intel.

Every question you answer will narrow ACME's map of the United States, leaving only the states that meet all the clues so far. The goal is to only have the one location left before your battery dies so the extraction team knows exactly where to pick Carmen up. So, tell me, "Where in the USA is Carmen Sandiego?"

Introduction

There are 195 countries in the world on a planet almost 200 million square miles in circumference. Let me ask you a question, can you locate Jamaica on a map? How about Luzon, or Samoa? Where is the Yukon, Westminster Abbey? What is Uluru commonly known as? If you cannot answer every one of these questions without looking up the answer, do not discouraged, this game will help.

"It's no secret that U.S. students are horrible at geography and have been for some time. Nearly three-quarters (77%) of eighth-graders tested below proficient in geography on the 2014 National Assessment of Educational Progress – also known as the Nation's Report Card – and that's almost exactly the same result (78%) as in 1994." (Camera, 2015)

This well-known issue is so common in America that even the famous, former nighttime host of NBC's Tonight Show, Jay Leno, held a recurring segment entitled "[JayWalking](#)". One segment since posted on [YouTube](#) gives a good summary of typical U.S. high school students' education (Videos, 2019). Although hilarious to watch, at the same time you are crying, partially from laughter and partially from the ignorance of the next generation. Do you really want the next President to think that the largest country in South America is Africa or that Toronto is a state in Canada?

Although there is not a quick solution to the problem, one popular game has tried to solve the problem for almost 40 years. "Where in the World is Carmen Sandiego" is a video game turned game show, turned television show. A survey from Netflix when launching the television show found that 16% of respondents credited Carmen for teaching them something meaningful about the world, and 20% of responses credited the game for instilling a sense of curiosity for the locations they learned about (Noonoo, 2019).

Geography is not everything, in addition to the terrain, one also needs to know about the people who live and work there. This work merges geography with census data to provide details on demographics, disability proportions, and populations to name a few criteria. To improve the world, all it takes is for one person to learn more than they knew the day before. So, gumshoe, as we follow in the footsteps of IBM, PBS, and Netflix, there is just one question left to answer: "Where in the USA is Carmen Sandiego?"

Materials and Methods

There are several modules that make up the program. The main module kickstarts the gameplay. You start by learning that Carmen Sandiego needs a quick hiding spot, and you, gumshoe, are the one for the job. If you are up to the task, you can hide Carmen and keep her safe from VILE.

Respond yes to start your quest. Whatever you do, do not forget where you told Carmen to hide, or ACME will never be able to find her!

The remainder of the main module loops through each question, displaying the possible options and awaiting the user's reply. If ACME narrows down the states

```
try:
    if (start[0].lower() == "y"):
        # Gameplay
        print("You are the only one who knows Carmen Sandiego's location. Do not forget it!")

        # Let's Begin!
        while (question_remaining >= 1 and len(state_options) > 1 and len(question_options) > 0):
            print("\nYour phone only has " + str(question_remaining) + "% battery remaining.")
            question()
            question_remaining -= 1

        # Determining Carmen's final location
        if (len(state_options) == 1):
            final_module.did_acme_find_carmen(state_options[0])
        elif (question_remaining == 0 or len(question_options) == 0):
            # Randomly select one of the remaining states and guess.
            print("\nLow Battery\nLow Battery\nLow Ba")
            final_module.did_acme_find_carmen(state_options[random.randint(0, len(state_options)-1)])
        else:
            raise Error()
    else:
        # User cannot hide Carmen and VILE wins.
        print("Carmen was not hidden in time and VILE has caught her.")
except:
    print("Game Over. VILE wins.")

Welcome gumshoe!

Carmen Sandiego is a professionally trained criminal mastermind who is working as a double agent to help the
Agency to Classify & Monitor Evildoers (ACME) stop the Villains International League of Evil's (VILE) thieving streak.
VILE is as red-hot on Carmen's trail as her trench coat and she needs a quick place to hide.
You call ACME to report Carmen Sandiego's location, but before you can speak to the extraction team, VILE is hot on your tail.

Thankfully VILE is better at stealing than at deciphering riddles and they are even worse with geography; so, you proceed to report her location via text.
Don't forget to be a good spy and use a code.
While running from VILE, ACME asks you easy to answer questions to try to narrow down your hiding spot for Carmen.
Your cell has only enough battery for 20 questions, so answer quickly before your cell battery dies.
If you cannot answer ACME's questions to help them find her before VILE, well let's not think about that.

You have all 50 United States to hide Carmen Sandiego.
See this picture up close: C:\Users\Megan\OneDrive\Desktop\School Documents\Grad School\GIS5653\Carmen Sandiego\Images\USA States In Play.jpg

Do you know where you want to hide Carmen? Yes/No 
```

to just one, or if the user runs out of battery, ACME guesses the state Carmen is in out of any remaining options; hopefully they guess correctly and rescue her, or VILE wins.

There is currently a bank of 20 questions that ACME has available to ask. Hopefully they can determine the correct state before then. They will ask the questions in a random order, and each question has a map associated with it. Each state is colored red, indicating an affirmative answer to the question, or blue, a negative response to the question. Answer truthfully or ACME will not be able to find Carmen's hiding spot. Every question you answer is one step closer to finding the correct location.

Questions cover anything from identifying if the state has an ocean view, to identifying

```
1 import arcpy
2
3 # This method uses the US Census data for race to determine differ
4 def census(question, datafiles):
5
6     populations_race = datafiles + "\\populations 2020"
7     age = datafiles + "\\age and sex 2020"
8     demographics = datafiles + "\\demographics 2020"
9     immigrant = datafiles + "\\immigrant 2020"
10    commute = datafiles + "\\transportation 2020"
11    school = datafiles + "\\school enrollment 2020"
12    disability = datafiles + "\\disability 2020"
13    population = []
14
15    if (question == "white" or question == "total"):
16        field_names = ['NAME', 'P1_001N', 'P1_003N']
17        cursor = arcpy.da.SearchCursor(populations_race+"\\populati
18    elif question == "african":
19        field_names = ["NAME", "DP05_0038PE"]
20        cursor = arcpy.da.SearchCursor(demographics+"\\demographics
```

the population, to the average commute time adults take to work. Each question has its own unique details including a question, a geospatial query, a map, and a list of states that satisfies the question. Majority of the questions come from the US Census Bureau and therefore loads

the census module, a separate module to handle the questions related to census data. There are seven folders containing different census data files that are used for the project, shown in the image above. In addition to pulling the data from the file, SQL queries are set for each of the questions. Then finally a query search of the database, an update to the state list, and the creation of the map for presentation to the player.

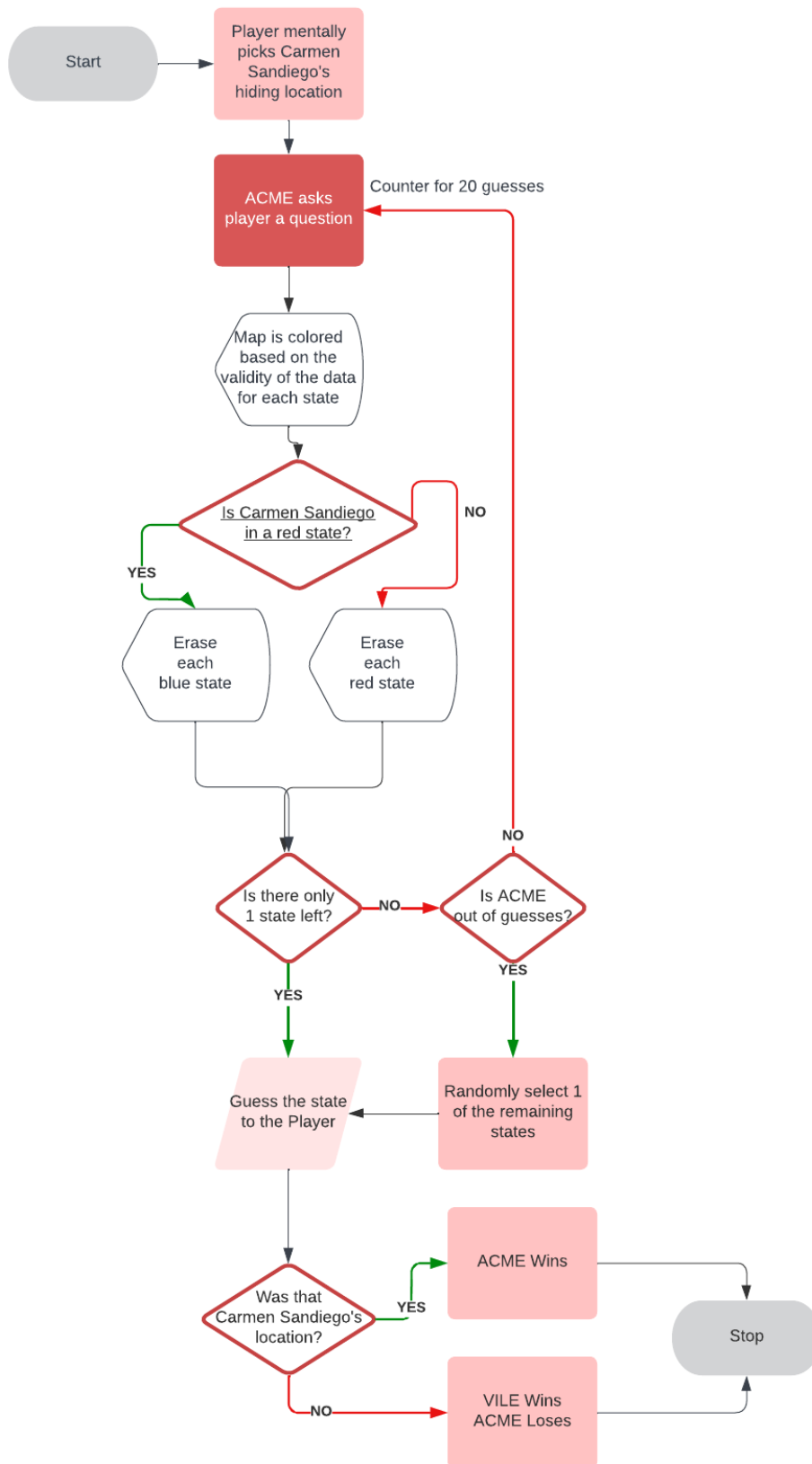
Other questions are more complex than basic SQL queries. To identify the states that have an ocean view, arcpy's analysis module and Intersect function is used to overlap the shapefile with

```
def us_costlines():
    in_table = datafiles + "\\tl_2019_us_coastline\\tl_2019_us_coastline.shp"
    arcpy.analysis.Intersect([states_file, in_table], "states_with_coastlines", "ALL")

    coastline_states = []
    ...
```

the map of each state with the shapefile of

the US coastlines. Then once the files are merged, the states that do not have a coastline are removed and the remaining state are the red, affirmative state options. Other arcpy functions like Buffer, SpatialJoin, and Clip are used for identifying the states west of the Mississippi River or those bordering other countries.



All the rules of gameplay are now known except for one—how to win. The workflow (shown left) shows the many possible paths the game can take. VILE wins in one of three ways:

1. If the player does not select a state to hide Carmen in time and VILE catches up to player.
2. If the player lies about which state they hid her in, meaning the remaining states are all incorrect so ACME looks in the wrong place.
3. The user's battery dies, and VILE sends their team to the correct state while ACME is lost in another state.

However, if the player answers all the questions truthfully, then ACME wins in two scenarios:

1. The questions ACME asks allows for the optional states to be narrowed down to a single state.
2. The player's battery dies, but ACME correctly guesses

which of the multiple states remaining to send the extraction team to.

Results

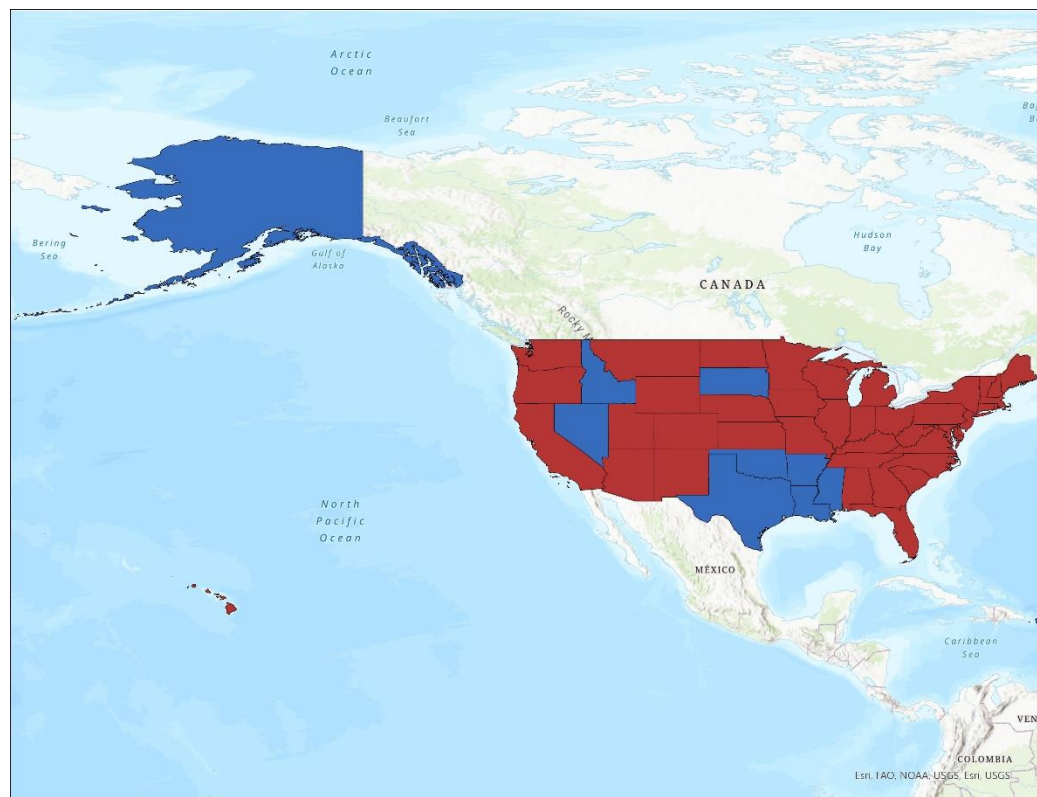
Every question answered is one step closer to Sandiego's location. For each question, displayed is the cell battery countdown, followed by the link to the image, then a list of the states that affirm the question and the states that are against the question, and finally the question and the response box. As shown in the figure to the right, any combination of "yes", "no" or simplified "y", "n" is accepted as valid input.

Your phone only has 19% battery remaining.
See this picture up close: C:\Users\Megan\OneDrive\Desktop\School Documents\Grad School\GIS5653\Carmen Sandiego\Images\disabled_sex.jpg
14 Red States for the Affirmative
Arkansas, Colorado, Hawaii, Kansas, Mississippi, Nebraska, Nevada, Oklahoma, Oregon, South Carolina, South Dakota, West Virginia, Wisconsin, Wyoming
22 Blue States for the Negative
Alabama, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Missouri, New Jersey, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee, Utah, Virginia
Does the state have a higher percentage of disabled men than women? n

Your phone only has 18% battery remaining.
See this picture up close: C:\Users\Megan\OneDrive\Desktop\School Documents\Grad School\GIS5653\Carmen Sandiego\Images\old.jpg
14 Red States for the Affirmative
Alabama, Connecticut, Delaware, Florida, Iowa, Kentucky, Massachusetts, Missouri, New Jersey, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee
8 Blue States for the Negative
California, Georgia, Illinois, Indiana, Louisiana, Maryland, Utah, Virginia
Is your state considered a retirement state? y

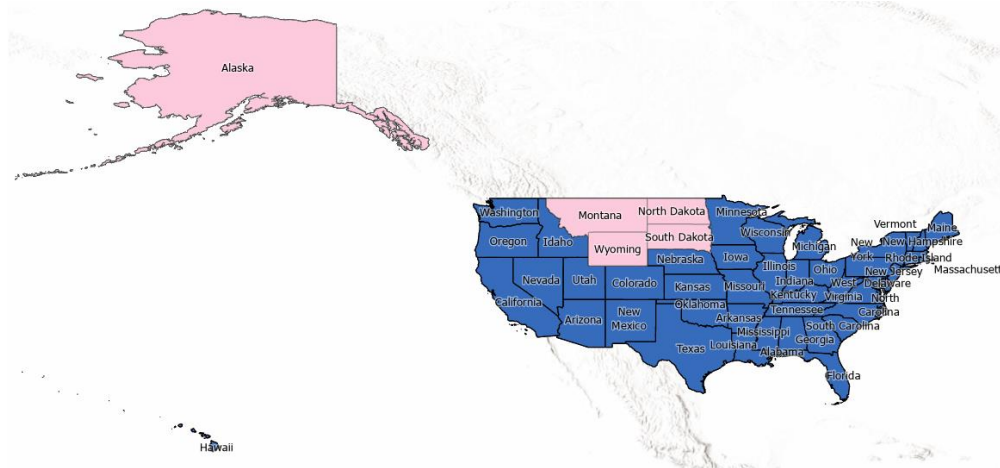
The result of the program is a bit non-conventional compared to traditional GIS programs. Instead of the final output showing a map with a call to action, the program is a series of maps, each with their own information hoping to spark appreciation for the country and provide educational information about each state. The map shown below is the result of the question:

"Does more than a quarter of the state's adults attend higher education?". This map shows 41 of the 50 United States do have college attendance over 25%, while the remaining nine states do not. No matter the user's opinion



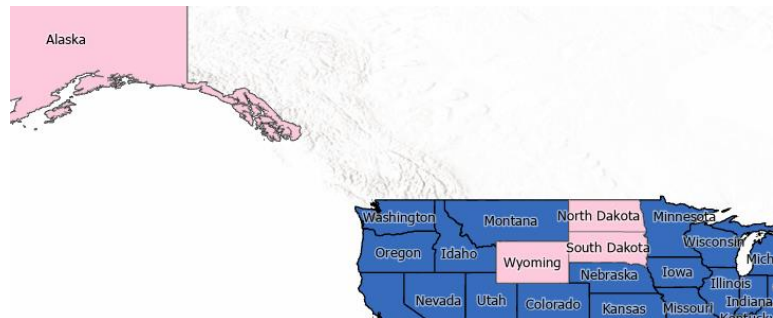
on college attendance, the result of this map is sure to surprise in some way. One would expect the low populated state of Alaska to be blue as there are not that many colleges in Alaska. However, many would also expect a state like Texas with many colleges to show red, or a state like Florida with majority of the adults being older than the standard college age showing as blue. Interesting, educational, and informative, that is just one of the questions available.

As the game progresses, ArcGIS Pro kept a map of the progress. The image shown below



on the left is the result of a game that appears almost over. There were 12 questions that produced this result; the blue states representing states that have been ruled out

from being Carmen's hiding spot; the remaining red states still in play. After the next question (results shown to the right), Montana is ruled out leaving both Dakotas, Wyoming, and Alaska as the only remaining possibilities. A few turns later, ACME wins and Carmen Sandiego was saved in Alaska.



Since every time the game is played the questions are asked in a different order, and the state chosen as the hiding location has the possibility of changing (if the user wants to choose a different location), then different combinations of different quantities of states are available. This means that every time the game is played one learns new information about the states, helping to provide a little unity and similarity to the states beyond what they voted in the last election. In the case of the run discussed above, Alaska, Montana, Wyoming, and North and South Dakota had at least 12 common factors.

Ultimately the result of the program is knowledge for the user. This program strives to accomplish the task in a fun and rememberable way. As the questions are asked and the states are eliminated, 1, 2, 5, 10, or even 20 at a time, the player is engrossed, excited, and exhilarated. When the final question appears, if everything went as planned and all 49 other

Did you hide Carmen Sandiego in Rhode Island? y
Congratulations! ACME successfully saved Carmen Sandiego from VILE.

states were eliminated, then congratulations should be in order.

Discussion and Conclusions

The outcome of the game is different for every iteration of the program. Although the exact result will vary for each execution, the result is the same: ACME makes one final guess at the state where Carmen is hiding, and their guess is either correct and they win, or incorrect and VILE wins. The maps that are created show important information such as each state's agreement with the question; the remaining states after each question; or displaying features such as the Mississippi River to identify the states westward.

Despite the positive outcome of the program there is room for future work.

As an example, it is currently possible that when a question loads all the states for the affirmative or negative have already been knocked out. Therefore, one advancement that needs to be added is a check for the number of states eligible for either the affirmative or negative, and if one category has all the states, skip the question, and try a different question. This will prevent the user from having to answer yes or no to a question that only has the one answer as the other side is void. This also requires a much larger question bank to pull from, as questions that are eliminated will not count towards the 20 questions in the gameplay.

An attempt at this solution was implemented, but then commented out. During runtime the code was intermittent at working and frequently failed if none of the states were for the affirmative. When the code segment did work as expected, it then broke the question counter and prevented the game from completing the loop, decrementing the question counter, and proceeding to the n-1 question for the player.

Another problem with the program is that images cannot be displayed inline, hence the need for the image link displayed to the customer instead of displaying the image outright. This is a stopgap as the user has the full file path to the image and can then open the file manually. This seems to be a limitation with Python and ArcGIS Pro itself; however, it would be more exciting for gameplay to resolve. Attempts at trying to show the picture inline were abandoned with both the inline call and single module call failed to display the image either during active gameplay or retroactively at the termination of the game. Attempts at opening the image as an alert or popup also fell short, but this may be due to want of understanding on such features.

Since ArcGIS Pro locks all files once they are touched, it is not possible to update the same image with the new information. One way to solve this to provide a final image would be to store each operation in order and then at the end of the game execute all the commands into one final image.

Lastly, a future enhancement is to work with the CSS stylings of the map layout and update the states with better labels and colors. This would allow for the features like mountains, state capitals, or airports to be toggled on and off the different maps, as well as allow for color assignment of the different state depending on multiple criteria, or even tracking the order in which the states were eliminated.

References

- American Community Survey. (2022, April 22). *DP05 ACS DEMOGRAPHIC AND HOUSING ESTIMATES*. Retrieved from United States Census Bureau:
<https://data.census.gov/cedsci/table?q=DP05&tid=ACSDP5Y2020.DP05>
- American Community Survey. (2022, June 30). *S0101 Age and Sex*. Retrieved from United States Census Bureau: <https://data.census.gov/cedsci/table?q=S0101&tid=ACSST5Y2020.S0101>
- American Community Survey. (2022, August 04). *S0501 SELECTED CHARACTERISTICS OF THE NATIVE AND FOREIGN-BORN POPULATIONS*. Retrieved from United States Census Bureau:
<https://data.census.gov/cedsci/table?q=S0501&tid=ACSST5Y2020.S0501>
- American Community Survey. (2022, August 13). *S0802 MEANS OF TRANSPORTATION TO WORK BY SELECTED CHARACTERISTICS*. Retrieved from United States Census Bureau:
<https://data.census.gov/cedsci/table?q=S0802&tid=ACSST5Y2020.S0802>
- American Community Survey. (2022, May 23). *S1810 DISABILITY CHARACTERISTICS*. Retrieved from United States Census Bureau:
<https://data.census.gov/cedsci/table?q=S1810&tid=ACSST5Y2020.S1810>
- American Consumer Survey. (2022, June 7). *S1401 SCHOOL ENROLLMENT*. Retrieved from United States Census Bureau: <https://data.census.gov/cedsci/table?q=S1401&tid=ACSST5Y2020.S1401>
- Decennial Census. (2022, April 25). *P1 RACE*. Retrieved from United States Census Bureau:
<https://data.census.gov/cedsci/table?q=P1&tid=DECENNIALPL2020.P1>
- National Oceanic and Atmospheric Administration. (2007, May 16). *Rivers of the U.S.* Retrieved from National Weather Service: <https://www.weather.gov/source/gis/Shapefiles/Misc/rs16my07.zip>
- United States Census Bureau. (2021, October 8). *Cartographic Boundary Files - Shapefile*. Retrieved from United States Census Bureau:
https://www2.census.gov/geo/tiger/GENZ2018/shp/cb_2018_us_state_500k.zip
- US Census Bureau, Department of Commerce. (2021, January 15). *TIGER/Line Shapefile, 2019, nation, U.S., Coastline National Shapefile*. Retrieved from Data.gov:
https://www2.census.gov/geo/tiger/TIGER2019/COASTLINE/tl_2019_us_coastline.zip