GEOG 3106-6306: DC Food Deserts

Database Relations/ Analysis, Euclidean Distance & MCE

Scenario: *With all the tourists who visit Washington D.C. for its architectural grandeur and countless museums, one may be inclined to believe all who live in the city are well off. However, there are many parts of the city that are underserved, particularly Anacostia. For instance, east of the Anacostia River there are only five grocery stores serving 160,000 people. The Mayor's Office wants your help to map the* ***food deserts*** *that exist in D.C. so it can develop a better understanding of how to provide access to quality produce for all Washingtonians. Read more about the situation from The Washington Post here and here, and East of the River.*

> ***What exactly is a food desert?***
> *According to the CDC, food deserts are "areas that lack access to affordable fruits, vegetables, whole grains, low-fat milk and other foods that make up a range of a healthy diet." Guidelines for what determines a food desert vary from organization to organization, but the USDA recognizes most models include a combination of the following factors:*
> - *Accessibility (how many healthy food sources exist or how far away the source is)*
> - *Individual barriers (lack of time in a person's schedule or lack of money to buy food)*
> - *Neighborhood indicators (reliable/ abundant transport or sub-poverty line incomes)*

For this assignment you must first build a basic model of food deserts guided by the Mayor's Office. After doing so, you will create your own Multi-Criterion Evaluation scheme to improve the accuracy of this model. Keep the above listed factors in mind while developing your own MCE.

The final report should be a minimum of 2 pages single-spaced with relevant supporting statistics/ graphics, plus two pages for the cartographic product. More information on the specific requirements for the writeup is found on the final page.

Section 1 — The Mayor's Predicted Demographic, Z-scores and MCE

The D.C. Mayor's office wants to identify Food Deserts lacking access to grocery stores while targeting young and low-income neighborhoods, especially east of the Anacostia River. To identify these areas the Mayor's office has asked you to 'somehow' combine measures of age, income and distance to grocery stores. The Mayor's office wants you to use data from the US Census Bureau which includes a series of socioeconomic and demographic indicators at different levels of aggregation, in this case at the census tract level. The standard proxy for wealth is median household income while median age is used for determining population age.

In order to make data comparable, it is necessary to standardize values that are initially not comparable with one another. This can be done by developing Z-Scores for each value given ***ONLY IF A DATASET IS APPROXIMATELY NORMALLY DISTRIBUTED***.

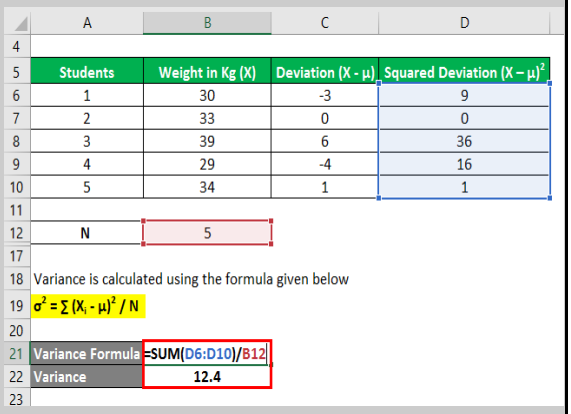
Z-Scores Intro

Z-Scores are a measure used to explain how far a particular individual (e.g. census tract) from the mean, measured in standard deviations. For instance, looking at income, if the Georgetown tract had a z-score of 2, it would imply that 97.7% of all other tracts had lower mean income.

There are a couple more variables you will need to understand before you can begin calculating this number. It is best explained via an example so you can see how it works. Assume we have a sample of individuals (X_i) with values 3.1, 4.6, 6.8, 9.2, 7.3 which are within a larger population; this is our sample data. The size of our sample is N and N = 5. We have a sample mean of $\overline{x}$= 6.2. Also, there is sample variance, which is found using the following equation:

$\sigma^2 = \sum (X_i - \underline{X})^2 / N - 1$

Where σ^2 is the variance of the sample; $\sum$ signifies you find the sum total of these values; X_i represents each of the point values X in our sample data and $\overline{x}$ represents the mean of X. From the variance, all you need to do is find its square root to get the standard deviation, a key component in the equation to produce z-scores.



	A	B	C	D
4				
5	Students	Weight in Kg (X)	Deviation (X - μ)	Squared Deviation $(X-\mu)^2$
6	1	30	-3	9
7	2	33	0	0
8	3	39	6	36
9	4	29	-4	16
10	5	34	1	1
11				
12	N	5		
17				
18	Variance is calculated using the formula given below			
19	$\sigma^2 = \sum (X_i - \mu)^2 / N$			
20				
21	Variance Formula	=SUM(D6:D10)/B12		
22	Variance	12.4		
23				

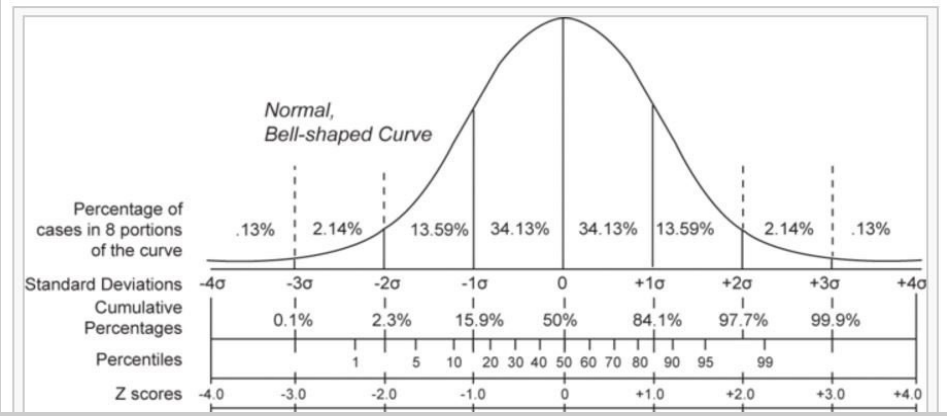
	X	$X_i - \overline{x}$	$(X_i - \overline{x})^2$	Z-Score
	3.1	-3.1	9.61	
	4.6	-1.6	2.56	
	6.8	.6	0.36	
	9.2	3.0	9.0	
	7.3	1.1	1.21	
$\sum$ (sum)	31	0	22.74	

Now, divide 22.74, your sum of all $(X_i - \underline{X})^2$ values by 5 (the number of sample values) - 1. Then, we need to calculate σ which is the square root of 5.685, which equals 2.3843, this is your SD or Standard Deviation value.

With that SD value you now know that 68.26% of all values should lie within 2.3843 (SD) of 6.2 (mean). Z-score is calculated, as previously mentioned, by subtracting the mean from the observed value and dividing by the standard deviation.

$$zscore = \frac{X_{i-\overline{X}}}{\sigma}$$

Find the Z-scores of the sample values above and record them in the table. These values will be submitted later through Blackboard.



Important: Z-Scores produce a value which puts any unstandardized numbers into context where a value is relative to the mean. For any normally distributed data we expect 68% of all values to be between -1 and 1, and approximately 96% to be between -2 and 2. This allows us to understand how far above or below the mean any given census tract is.

Now, if we relate it back to the target demographics as suggested by the Mayor's office, the goal is to find Census tracts in DC with low Z-scores, corresponding to low household income and low median age.

Multi Criteria Evaluation (MCE) Values

When evaluating different variables it is possible to assign numeric values that indicate higher importance to specific variables. If we are selecting areas where young people with low incomes live, we could create two indexes with weights for each criterion (e.g. Age Index and Income Index). We could assign an Age Index value from 0 to 1. Assigning 1 to all the counties where the youngest families live. Accordingly, we could assign an Income Index of 1 to all the counties where the median income is lowest. We can assign values closer to zero for both criteria to the areas that are wealthy and elderly. The sum of these two indexes (i.e. the MCE index) for each area would return higher values for low income tracts with younger populations and low values for those that do not match these criteria.

Keep three things in mind during analysis:

1. Incomes cannot range far from the mean in a negative direction and there is a definitive minimum on the low end in terms of standard deviations. When you reach the "zero income" level you cannot get any lower. This is called truncation.
2. Consider the concept of an "ecological fallacy," the idea that one should not confuse the attributes of an area with the individuals living within them. If you assume connections between income levels in a census tract with other demographic information you are often making a mistake. If a county has a high median household income and a large percentage of the residents in that county are farmers, there is no reason to assume that the farmers are rich.
3. MCE Criteria are almost always inherently subjective. Subjectivity is fine as long as you explicitly state the logic behind the choices you make. Be sure to include these explanations in your writeup.

Section 2 — Compiling, Clipping and Modifying Data

For this lab you will download demographic data from the U.S. Census and spatial data from Open Data DC.

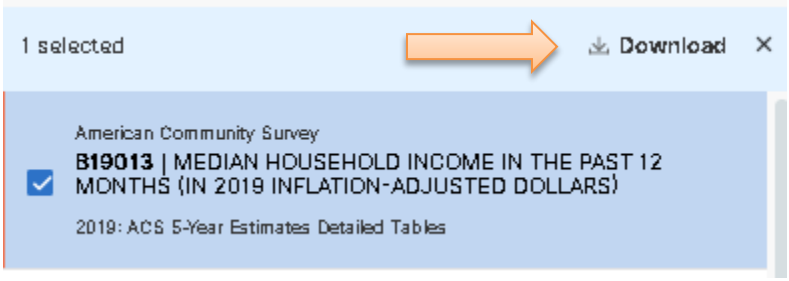
- U.S. Census Bureau Advanced Search
  - https://data.census.gov/cedsci/advanced
  - 2019 TIGER/Line® Shapefiles: Census Tracts
- Open Data D.C.
  - ACS Economic Characteristics DC Census Tract
  - Also find "Grocery Store Locations"
  - Military Bases
  - National Parks
  - Waterbodies

Downloading and Unpacking Data

1. Use the advanced search on the Census Bureau website, navigating to **Geography** on the left side, next "Census Tract," under **Within other geographies** choose "District of Columbia" and check "All Census Tracts within District of Columbia".
2. On the left scroll down to "Years" and check the box for "2019"
3. In Table ID, 

write the following: "Median Household Income in the Past 12 Months", and use the **Search button ALL THE WAY DOWN ON FAR BOTTOM RIGHT.**
4. **Choose** "Median Income in Past 12 Months (Inflation adjusted)", Table B19013, if you don't see the list of tables click on 

tab near the upper left
5. In the **Results** list, **Select** the table again, then click **Download.** This data table is in .csv format. The column we are interested in is labeled B19013_001E. Be sure to save all files to your folder in the S: drive.



6. **Return** to the query page and repeat the process search for Median Age in the Table ID box and **download** "Median Age by Sex" Table **B01002** for 2019. We are interested in the column B01002_001E. Be sure to use the same geographic selections as Median Household Income.
7. Click the above link for the **2019 TIGER/Line Shapefile for Census Tracts** and download it for D.C.
8. Now, navigate to the Open Data D.C. website using the above link. Download the ***ACS Economic Characteristics*** (NOT EXPERIMENTAL) data table. This table will be helpful when you develop your own MCE.

	A	B	C	D	E
1	id	id2	Geographic Area Name	MEDIAN_AGE	
2	1400000US11001000100	11001000100	Census Tract 1, District of Columbia, District	45.1	
3	1400000US11001000201	11001000201	Census Tract 2.01, District of Columbia, Distr	19.8	
4	1400000US11001000202	11001000202	Census Tract 2.02, District of Columbia, Distr	27	
5	1400000US11001000300	11001000300	Census Tract 3, District of Columbia, District	31.2	
6	1400000US11001000400	11001000400	Census Tract 4, District of Columbia, District	43.1	
7	1400000US11001000501	11001000501	Census Tract 5.01, District of Columbia, Distr	35.3	
8	1400000US11001000502	11001000502	Census Tract 5.02, District of Columbia, Distr	39.3	
9	1400000US11001000600	11001000600	Census Tract 6, District of Columbia, District	45.8	
10	1400000US11001000701	11001000701	Census Tract 7.01, District of Columbia, Distr	47.1	
11	1400000US11001000702	11001000702	Census Tract 7.02, District of Columbia, Distr	34.7	
12	1400000US11001000801	11001000801	Census Tract 8.01, District of Columbia, Distr	42.7	
13	1400000US11001000802	11001000802	Census Tract 8.02, District of Columbia, Distr	35.8	
14	1400000US11001000901	11001000901	Census Tract 9.01, District of Columbia, Distr	20.4	
15	1400000US11001000902	11001000902	Census Tract 9.02, District of Columbia, Distr	45	
16	1400000US11001001001	11001001001	Census Tract 10.01, District of Columbia, Dist	44	
17	1400000US11001001002	11001001002	Census Tract 10.02, District of Columbia, Dist	30.2	
18	1400000US11001001100	11001001100	Census Tract 11, District of Columbia, Distric	43.9	

9. Finally, using the search feature on the Open Data website, download ***Military Bases, National Parks, Waterbodies,*** *and* ***Grocery Stores*** as shapefiles and add them to your folder.
10. Now that you have downloaded all the files, unzip them in your folder. The two .csv files will have multiple Excel tables available, but the only ones we're interested in are the files labeled "_Data.csv"
11. Open the .csv file that corresponds to Median Income. Delete the **second** header row and all columns except for **GEO_ID** (rename this as id), **NAME** and for **"B19013_001E"** rename it **MEDIAN_INCOME** (the labels are difficult to read so expand columns to verify you deleted the correct ones). Delete the District of Columbia median age row at the very bottom row as well.
12. Create a new column next to **id** named **id2**.
13. **id2** is produced using the last 11 digits of **id** in Column A. Use the following function to transfer this data to the **id2** column *without* the brackets: [[=right(A2,11)]] Apply this function to every row that follows by clicking and dragging the formula down the column, or copy and pasting it.
14. Be sure to only have one header row or else your variables will be labeled as numbers and letters in ArcGIS Pro. Rename the sheet Median_Income in the lower left corner.

	A	B	C	D	E
1	id	id2	Geographic Area Name	MEDIAN_INCOME	
2	1400000US11001000100	=right(A2,11)	Census Tract 1, District of Colu	192727	
3	1400000US11001000201	11001000201	Census Tract 2.01, District of Columbia, District of Colu		
4	1400000US11001000202	11001000202	Census Tract 2.02, District of Co	205326	
5	1400000US11001000300	11001000300	Census Tract 3, District of Colu	147431	
6	1400000US11001000400	11001000400	Census Tract 4, District of Colu	140536	
7	1400000US11001000501	11001000501	Census Tract 5.01, District of Co	125972	
8	1400000US11001000502	11001000502	Census Tract 5.02, District of Co	150104	

15. Save the file as Median_Income in your folder and select Excel Workbook as your file type. It is extremely important to use an Excel Workbook (.xls or .xlsx) instead of saving as a .csv because .csv will not maintain numeric columns being stored as text
16. Open the Median Income file in Excel.

17. Repeat steps 9 through 13 to produce your MEDIAN_AGE Excel Workbook. **NOTE**: If you notice values in the MEDIAN_INCOME or MEDIAN_AGE columnS which are not entirely numeric (such as 250000+ or -) delete these symbols to ensure this field appears as a numeric variable in ArcGIS Pro.
18. Close Excel once you are finished.

Loading the data into ArcGIS Pro

19. Unzip the tl_2019_11_tract folder if you haven't done so already.
20. Open a new Map session of ArcGIS Pro and add the census tracts shapefile to the map.
21. Check the shapefile's properties to verify the Spatial Reference is Geographic Lat Lon with NAD83 (North American Datum 1983).
22. Add the two excel sheets Median_Age and Median_Income.

Geographic Coordinate System	NAD 1983
WKID	4269
Authority	EPSG
Angular Unit	Degree (0.0174532925199433)
Prime Meridian	Greenwich (0.0)
Datum	D North American 1983
Spheroid	GRS 1980
Semimajor Axis	6378137.0
Semiminor Axis	6356752.314140356
Inverse Flattening	298.257222101

Joins and Relates: Part A

23. In order to join the demographic tables to the shapefile (link the spatial with the attribute data), we need to use an unique KEY FIELD. This key field is a column in both the source and the target tables that contains the exact same information and data format type. In this part of the lab we will join the demographic tables (targets) to the shapefile's attribute table (source).
24. Open the shapefile's attribute table as well as Median_Age's by right clicking. View the column names. GEOID in the DC tract shapefile attribute table corresponds to the id2 variable you previously created in Excel but the variable type is different. You can check the variable type by hovering over the column label at the top of the table.
25. In order to join two tables, it is necessary to have corresponding data types and columns so you must create a new variable in the tl_2019_11_tract shapefile table called **id2**.
26. **id2** should be made a "Text" field type to correspond with the Excel files. Once you have created the new field, populate it with the field calculator.
27. Joins and relates are only temporary. **Make sure to** write out your tracts with income and age data to a file geodatabase.

Validating Geometry and Reprojecting

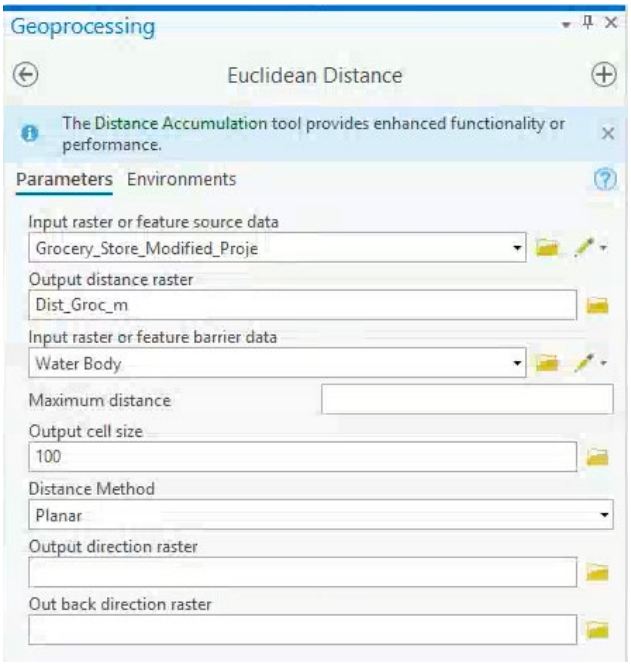
28. Add the Waterbodies, National Parks and Military Bases shapefiles to your map. Color these items to assist when you produce your final map product.
29. Validate the geometry of all these shapefiles using the tool found by using the search bar in the top right-hand corner. Some of the geometries are not complete and thus create issues during the Euclidean Distance processing later on.
30. Use the search bar in the top right-hand corner to find the Erase tool. Open the tool and use the three shapefiles you just added as cookie cutters to remove these areas (water, parks, and military bases) from the Census tracts. Erase all three and save the new edited tracts naming the file "DC_Tracts_Final". We want our food desert map to be as accurate as possible.
31. Add the Grocery Store Locations point feature to the map.
32. Find the Project tool using the search bar in the top right corner. We want to reproject the grocery store locations layer from NAD 1983 to the NAD 1983 (2011) StatePlane Maryland FIPS 1900

(Meters) projection. This will help us later when we want to specify distances in meters using the Euclidean Distance geoprocessing tool.

33. Remove and delete the non-state plane version to avoid using it by accident.

Section 3 — Euclidean Distance, Joins, Z-Scores & Zonal Statistics

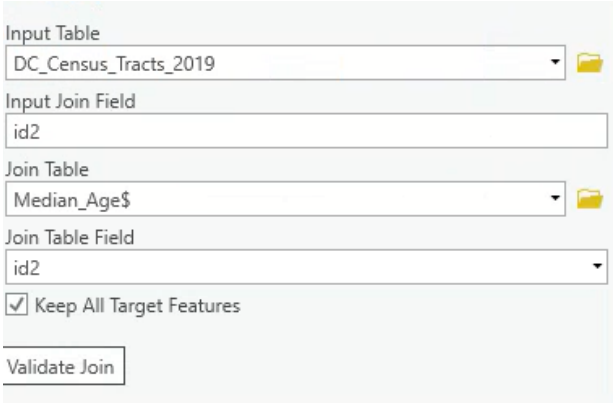
Euclidean Distance



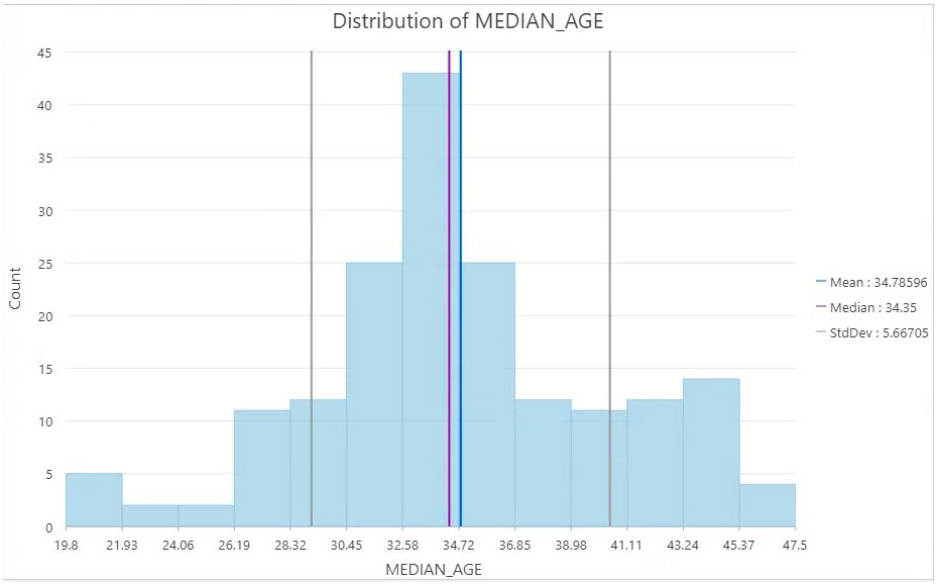
34. Open the **Euclidean Distance** tool and fill in the *Input raster or feature source data* with your reprojected Grocery Store point data file. Be sure to select the correct file.
35. The Output distance raster name will automatically populate but change the name to *Dist_Grocery_m*. Try to abide by best practices with regards to naming conventions.
36. Next, in *Input raster or feature barrier data*, select the waterbodies file. It's reasonable to assume people would likely refrain from crossing a river to travel to the nearest grocery store and, by entering a shapefile here, it limits the Euclidean distance from being calculated across these water features. Leave the maximum distance blank.
37. Set the output cell size to 100. This is in meters because the *linear unit* of the Maryland FIPS projection is meters.
38. Leave the rest on this page as is. Click to *environments* and use the DC census tracts shapefile as the *processing extent*. Otherwise, distances will only be calculated to the extent of the grocery store point file, not for all of DC.
39. Run the Euclidean Distance tool. The raster file should appear on the Map.
40. Search for the *Raster Calculator* tool and multiply your Euclidean Distance grocery store file by itself. The reason why we square the raster values is to exacerbate the distance values, or severely penalize raster cells that are extremely far from the nearest grocery store. Name your file appropriately and click run. The squared raster file should appear on the Map.

Joins and Relates: Part B

41. First we will join the two census tables using id2. We are doing this because we want to combine the information (Income and Age) into one table. Right click on **Median_Age** and select *Joins and Relates* > *Join*
42. Choose the field id2 as the field that the join will be based on and to base the join on. Be sure that the **Median_Income** is the table that will be used to join to **Median_Age**. Validate your join to ensure your id2 columns match. After clicking OK, both tables (Income and Age) will be joined into one table. Open the table to double check. Note that you will have some duplicate columns, this is fine, they still hold the original data.



43. Now, we will join the census tract shapefile's attribute table and the recently joined demographic datatables using the **id2** "text" field that you created. Use the figure at right as guidance when entering fields for the Joins.
44. In order to make the joins permanent (at this point they are temporary and will be lost if you close ArcGIS Pro), we need to create a new shapefile with the joined tables.
45. Right click on the tracts layer and navigate to Data and Export Data. Save the new shapefile in your S: Drive folder. Name the new shapefile as **DC_age_income.shp** (so you know that this is the file that contains said information).
46. Add the new shapefile you just created to the map if it isn't added automatically. You can remove the first edition with the temporary joins.



Z-Scores

47. Open the attribute table and add two new FLOAT type fields and call them Z_age and Z_income (you don't have to set the precision or scale).
48. Add an additional two FLOAT type weight fields for each Z-score and name them age_scaled and income_scaled. Add a third FLOAT type weight field for distance to the nearest grocery store; call it dist_scaled.
49. To calculate the Z-scores you will need to obtain descriptive statistics for your variables first.
50. Open the attribute table of the new shapefile and right-click on Median_Age and select *statistics*.
51. A window will appear with the descriptive statistics you need to calculate the Z-scores.
52. Write down the SD and mean for both median age and income.

53. Right-click on the field label “Z_age” and open the field calculator. Enter the formula to calculate the Z-score for age. Refer back to the Z-score example you completed previously if you're unsure of the formula.
54. Repeat these steps for calculating Z-scores for median income.
55. **Now write down the z-scores you calculated for both income and age for tract 98.10. You will need to submit this to Blackboard later.**
56. Now that you have the Z-scores for both demographic variables (income and median age) we will rescale them between 0 and 1. This rescaling method is largely arbitrary but allows us to give higher scores to poorer and younger census tracts. Use the following code in the field calculator to rescale z-scores for each tract for both the age and income data.

Field Calculator Example for Rescaling Age Z-Scores

age_scaled =

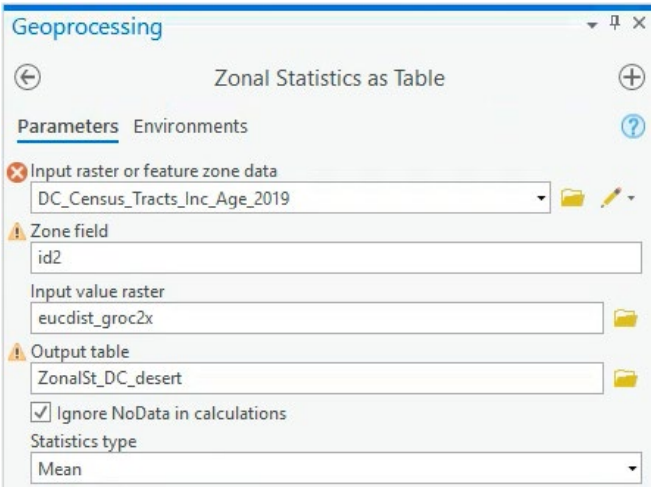
Reclass(!Z_age!)

Code Block

```
def Reclass(input):
 if (input < -1.5):
  return 1
 if (input > -1.5 and input <= -1):
  return 0.85
 if (input > -1 and input <= -0.5):
  return .7
 if (input > -0.5 and input <= 0.5):
  return 0.5
 if (input > 0.5 and input <= 1):
  return 0.3
 if (input > 1 and input <= 1.5):
  return 0.2
 else:
  return 0.1
```

Zonal Statistics

57. Now, find the *Zonal Statistics as Table* tool using the search function.
58. In the *Input raster or feature zone data*, select your DC census tract file with the age and income data, and rescaled z-scores.
59. Choose **id2** as your zone field, because it has a unique value for each census tract.
60. Select the squared Euclidean distance file you made with the raster calculator as your input value raster.
61. Name your output table appropriately and save it to your S: drive folder.
62. Check on the Ignore NoData in calculations and set the statistics type to **Mean** instead of All.
63. Click run and find the resulting standalone output table.



64. Join this table to the same table you used as Input raster or feature zone data in the first field option of the tool.
65. **Record the grocery distance squared value (column called MEAN) associated with tract # 98.10, as above, this will be submitted to Blackboard.**
66. Open the fields table and add a FLOAT type variable named *dist_scaled*. Click save.
67. Find the statistics of MEAN and record the minimum and maximum values.
68. Like we did in class, use the field calculator to normalize these values onto a 0 to 1 scale using min max scaling. Use the formula $(X_i - X_{min})/((X_max - X_{min}))$ to calculate the values of dist_scaled. The resulting numbers are similar to the weights you calculated for age and income previously.
69. **Record the *dist_scaled* value associated with tract # 98.10, this will be submitted to Blackboard.**

MCE

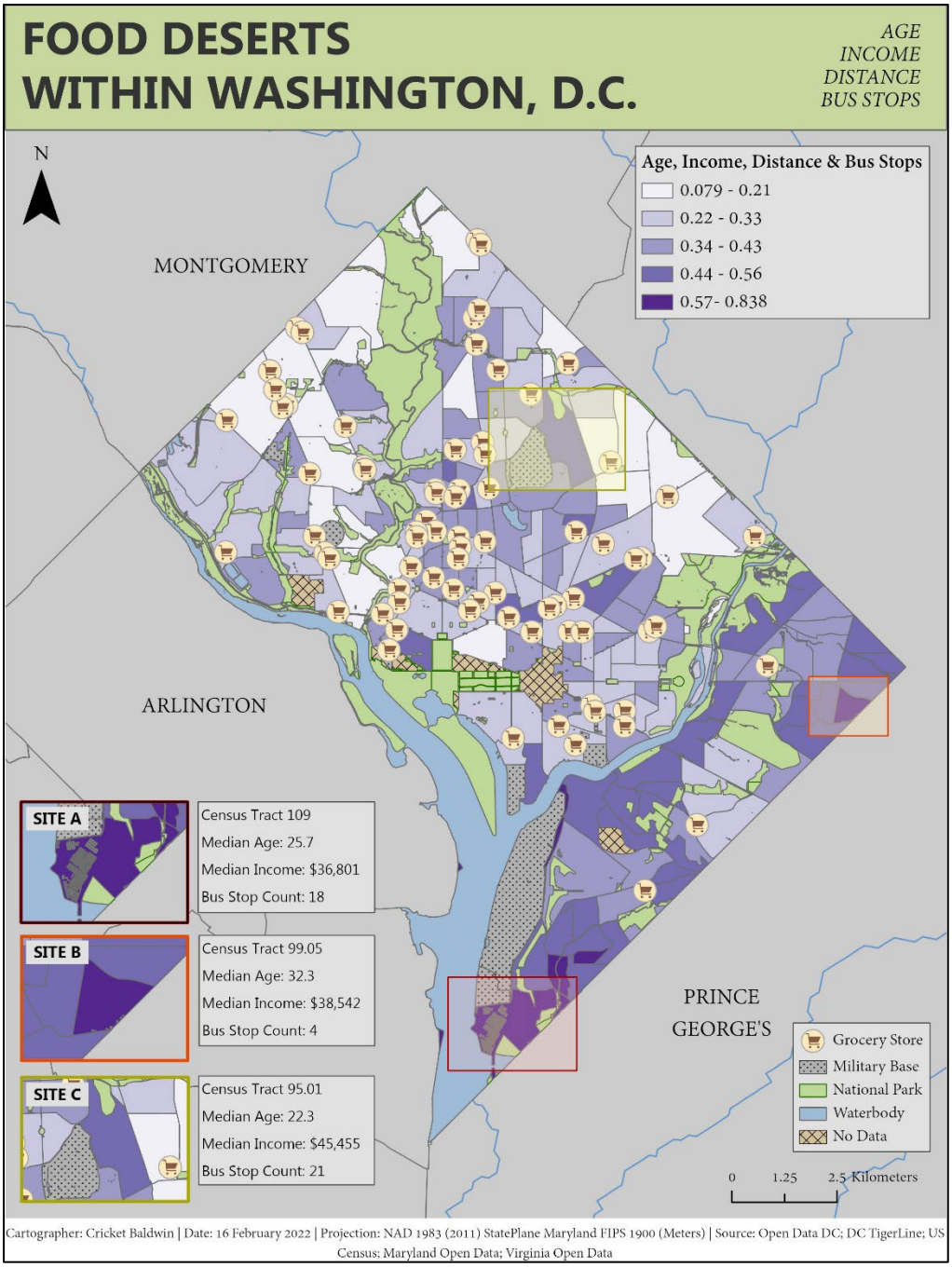
70. Once you have finished assigning weights, create a new FLOAT type field and call it MCE. This field will contain the *weighted sum* of age, income and mean squared distances from each tract to the nearest grocery store.
71. Right click on the MCE field's name using the Field Calculator (age_scaled * 0.15 + income_scaled * 0.30 + dist_scaled * 0.55). The values in the MCE field should range somewhere between 0 and 1. Tracts with an MCE value closer to 1, according to the Mayor Office's prediction, should reflect areas they believe are food deserts.
72. **Record the answer to the following question: "Based on your MCE weights, how many times as important is income_scaled compared to age_scaled in the final MCE score?" This will be submitted to Blackboard later.**

Your moment of contemplation:
How could this methodology be improved? Are we missing anything etc.? Note this in your report.

73. Right click and go to Symbology for the tracts shapefile. Select an adequate color scheme to represent MCE variation. Go to classify and use graduated symbology for your MCE. Choose an interval method as well.
74. Now, find and insert US counties, water bodies file for neighboring counties around DC, etc. to geographically contextualize the city. The best sources for this are likely state GIS portals.
75. Add all elements required in the map grading rubric (on Blackboard).
76. Your final map should look something like this (but I know you can do much better - especially if you develop your own MCE). Find a way to make the census tracts which you determine to be food deserts stand out more than the sample below.
77. Now, it's time to ***create your own MCE*** using values included in datasets you find on the U.S. Census Bureau website or from the ACS Economic Characteristics table downloaded previously.
    a. **Undergraduates**: Add one more variable of interest, make sure to think about how you will rescale the data (and why), and what weight you will assign to it in your MCE weighted sum. Make sure you can justify your choices. Avoid multicollinearity amongst your variables by picking characteristics that are different from one another or else risk building an invalid model.
    b. **Graduate Students:** Start fresh, create an MCE that identifies communities with a high % of elderly residents and residents living below the poverty line, that live far from grocery stores, AND have few bus stops. This data is available through Open Data DC.

Make sure to record the column names of the variables you add, your method for counting bus stops, your rescaling methods and MCE weights.

78. Create a second map highlighting the results. Use inset maps to highlight areas where new grocery stores might be targeted.



Deliverables

Check Blackboard for assignment due date. Grading will roughly follow these percentages: Answers to questions 25%, maps 25%, writeup 50%.

Compile answers to the following embedded questions to be submitted to Blackboard via a submission test:

- z-scores you calculated for both income and age for tract #98.10.
- the grocery distance squared value (column called MEAN) associated with tract # 98.10
- dist_scaled value associated with tract # 98.10,
- **Based on your MCE weights,** how many times as important is income_scaled compared to age_scaled in the final MCE score?

Turn in a 4+ page (2-3 single spaced text with tables + 2 pages for your maps) professional digital report summarizing the methodology in an accessible fashion for the D.C. Mayor's Office along with your cartographic results. Consider the audience of your report – city policy makers. Clearly explain what your objectives are, how you got to your conclusion and why it's important. Be thorough, bring to light any interesting findings, discuss the implications.

- Include a(n):
  - ☐ **Abstract** of the report,
    - ☐ including a concise (3-4) sentence high-level summary of the report—clarifying the topic and major findings/recommendations. This may be the only part some of the mayor's staff will read, so be sure all critical information for them is here (and described in greater detail later in the report).
  - **Introduction** to the problem,
    - ☐ including a brief summary of food deserts, please do a bit of research and include a well-worded description. **Include** direct quotes from at least two sources. Please record all citations APA style.
    - ☐ the relevance of food deserts to DC,
    - ☐ and outline the Mayor's and your approach to the problem.
  - **Data & Methods** section outlining how you completed the task,
    - ☐ include a general description of the data used and cite it in APA style pointing to the data source
    - ☐ include any formulas used like the z-score (with a paragraph description of how it is used and why?) Also address the following questions:
    - ☐ Why did you use z-score to normalize certain variables?
    - ☐ Why did you not use it with other variables? Why min/max scaling instead?
    - ☐ What were the variables you ultimately used for your final MCE?
    - ☐ How do these variables address the USDA criteria in determining the location of food deserts domestically?
    - ☐ What does a high score mean in your MCE?
    - ☐ To help remember what to report please include the following table in your method section include all variables used in your final updated MCE:

Variable Name	Scaling Method	MCE weight	MCE weight justification	Justification for Inclusion
Example	z-score	0.2	½ the importance as variable x	Example is an important indicator of community blah blah
Additional Map 2 Variables				
New Variable				

- **Results** section:
  - ☐ Referring to your maps by figure number, describe the results from your MCE models, what areas are most in need of grocery stores? Why?
  - ☐ How are the two methods different?
  - ☐ Do they significantly change the results? If so, choose the best one and defend that choice.
  - ☐ If you propose particular sites for new grocery stores on your maps, defend those choices here, make sure to refer to them by site label e.g. “Site A”
- **Conclusion** section providing an overview of the problem,
  - ☐ how you addressed it, and
  - ☐ summarize what the results were.
- **References** in APA format (not footnotes). Do not plagiarize!
- **2 Maps**, each figure should take up a full page
  - ☐ At the end of the document saved in pdf format (use adobe acrobat to combine your text and figures)
  - ☐ include all required elements, and a meaningful title e.g. Figure 1 - Food deserts of DC 2019 - Mayor’s Method.
  - ☐ Please refer to these figures by number in the text of your results section. (e.g. “Looking Figure 2 we can see that…”
  - ☐ The second map should show the results of the MCE that includes one or more new variables.
  - ☐ In the second map, use inset maps to highlight areas where new grocery stores should be targeted. If possible select 3 sites, consider labeling them A, B, and C and refer to those sites in your results section.
  - ☐ Both maps should highlight the food deserts, show where the grocery stores are located in DC, and all important cartographic elements.
  - ☐ Your audience is the DC Mayor’s office, so your map projection, scale bar, and contextual layers and labels should reflect this—no Web Mercator!

Again, the map design write-up can be an additional document uploaded to Blackboard, written into Blackboard directly, or as an appendix to this report.