Baltimore Maps

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Final Baltimore Overdose Project

```
#load packages
library(tidycensus)
library(tidyverse)
library(sf)
library(sp)
library(crsuggest)
library(tigris)
library(tmap)
library(spdep)
library(units)
options(tigris_use_cache = TRUE)
```

Set Up

First bring in shapefile containing point locations for Naloxone providers in Baltimore City

```
#bring in Naloxone distribution point locations

NarcanBalt <- st_read("./data/Balnarcan_points/Balnarcan_points.shp")
```

```
## Reading layer `Balnarcan_points' from data source
##   `G:\My Drive\GES_486\Final_Project\data\Balnarcan_points\Balnarcan_points.shp'
##   using driver `ESRI Shapefile'
## Simple feature collection with 16 features and 10 fields
## Geometry type: POINT
## Dimension:     XYZ
## Bounding box:  xmin: -76.70957 ymin: 39.28305 xmax: -76.57744 ymax: 39.3646
## z_range:       zmin: 0 zmax: 0
## Geodetic CRS:  WGS 84 + EGM96 height
```

Bring in Overdose calls for service by CSA shapefile

```
#bring in overdose shapefile from previous project

CSA_overdose <- st_read("./data/Number_of_Overdose_Calls_for_Service_per_1%2C000_Residents (1)")
```

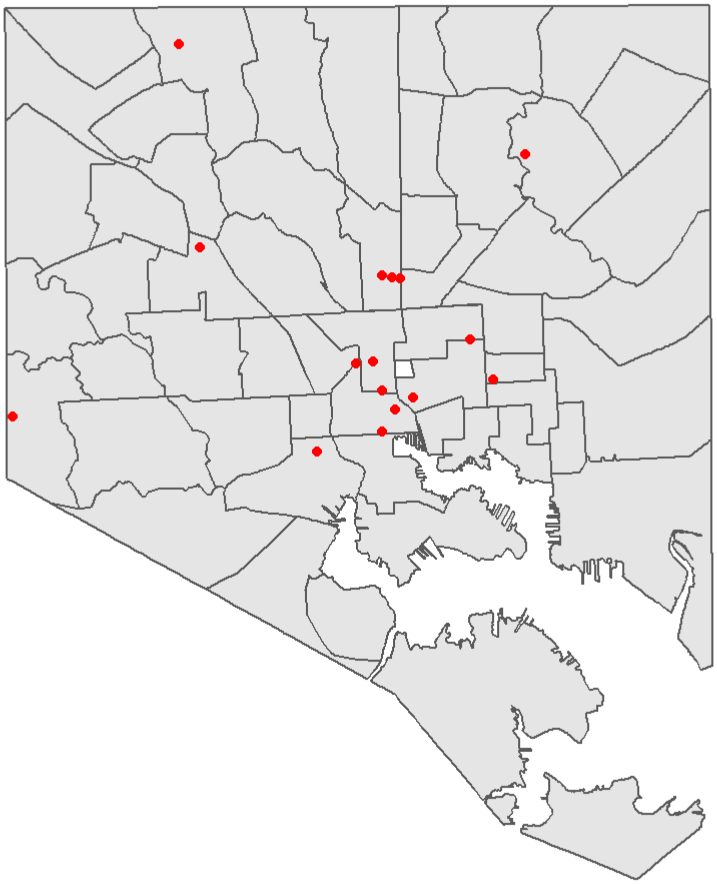
```
## Reading layer `Number_of_Overdose_Calls_for_Service_per_1%2C000_Residents' from data source `
G:\My Drive\GES_486\Final_Project\data\Number_of_Overdose_Calls_for_Service_per_1%2C000_Resident
s (1)'
##   using driver `ESRI Shapefile'
## Simple feature collection with 55 features and 8 fields
## Geometry type: MULTIPOLYGON
## Dimension:     XY
## Bounding box:  xmin: 1393927 ymin: 557733.6 xmax: 1445503 ymax: 621406.8
## Projected CRS: NAD83 / Maryland (ftUS)
```

Transform both shapefiles into MD state plane

```
#transform both shapefiles into MD state Plane CRS 6488

NarcanBalt_proj <- st_transform(NarcanBalt, crs= 6488)
CSA_overdose_proj <- st_transform(CSA_overdose, crs = 6488)
```

Plotting Naloxone Provider locations

```
#Plot Naloxone Distribution locations over Baltimore CSA's

ggplot() +
  geom_sf(data = CSA_overdose) +
  geom_sf(data = NarcanBalt_proj, fill = "red", color = "red") +
  theme_void()
```

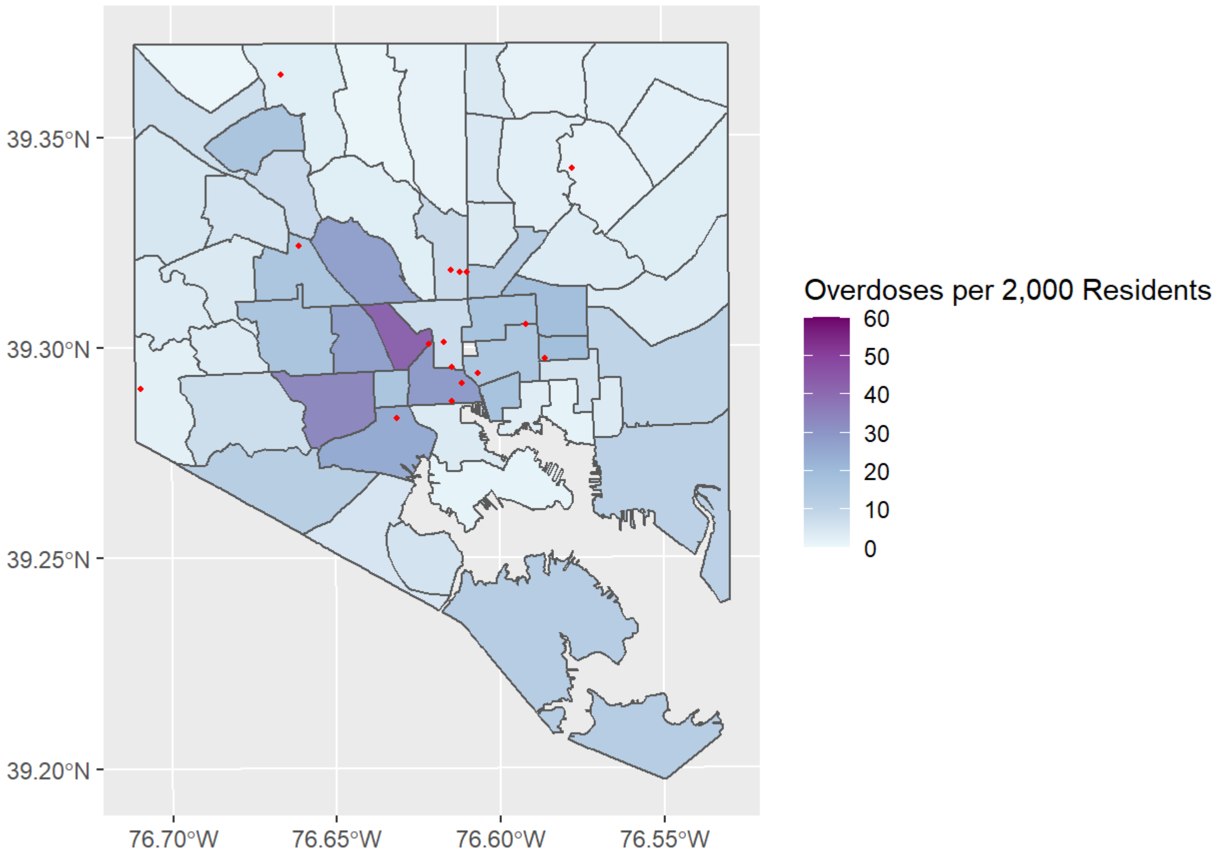


Mapping Provider Locations and Overdoses by CSA

Plot Naloxone provider locations over choropleth map of overdose calls for service by CSA shapefile for year 2020

```
#plot Naloxone points over choropleth map of overdose calls per 2,000 residents
Overdose20_points <- ggplot() +
  geom_sf(data = CSA_overdose_proj, aes (fill = overd20)) +
  geom_sf(data = NarcanBalt_proj, fill = "red", color = "red", size = 0.8) +

  scale_fill_distiller(palette = "BuPu",
                       direction = 1,
                       limits =c(0,60),
                       breaks=c(0,10,20,30,40,50,60)) +

  labs(title = "  2020 Overdoses ",
       caption = "Data source: Open Baltimore",
       fill = "Overdoses per 2,000 Residents") +
  theme_gray()
Overdose20_points
```

2020 Overdoses



Data source: Open Baltimore

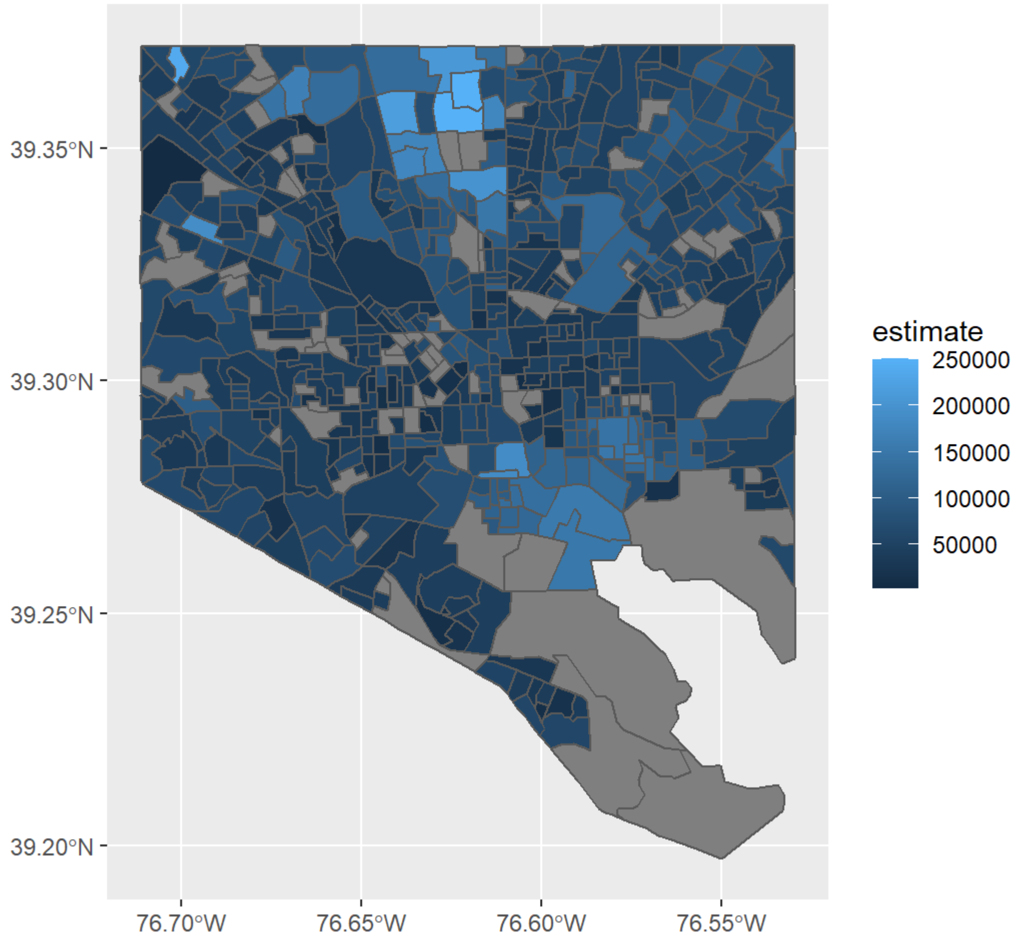
Mapping Provider Locations and Median Household Income by Census Tract

Use tidycensus to get 2020 Median Household Income by census tract in Baltimore City

```
#Use tidycensus to get Median Household Income for Baltimore City Census tracts

bal_MHI <- get_acs(
  geography = "block group",
  state = "MD",
  county = "Baltimore City",
  year = 2020,
  variables = "B19013_001",
  geometry = TRUE
)

plot(bal_MHI$geometry)
```

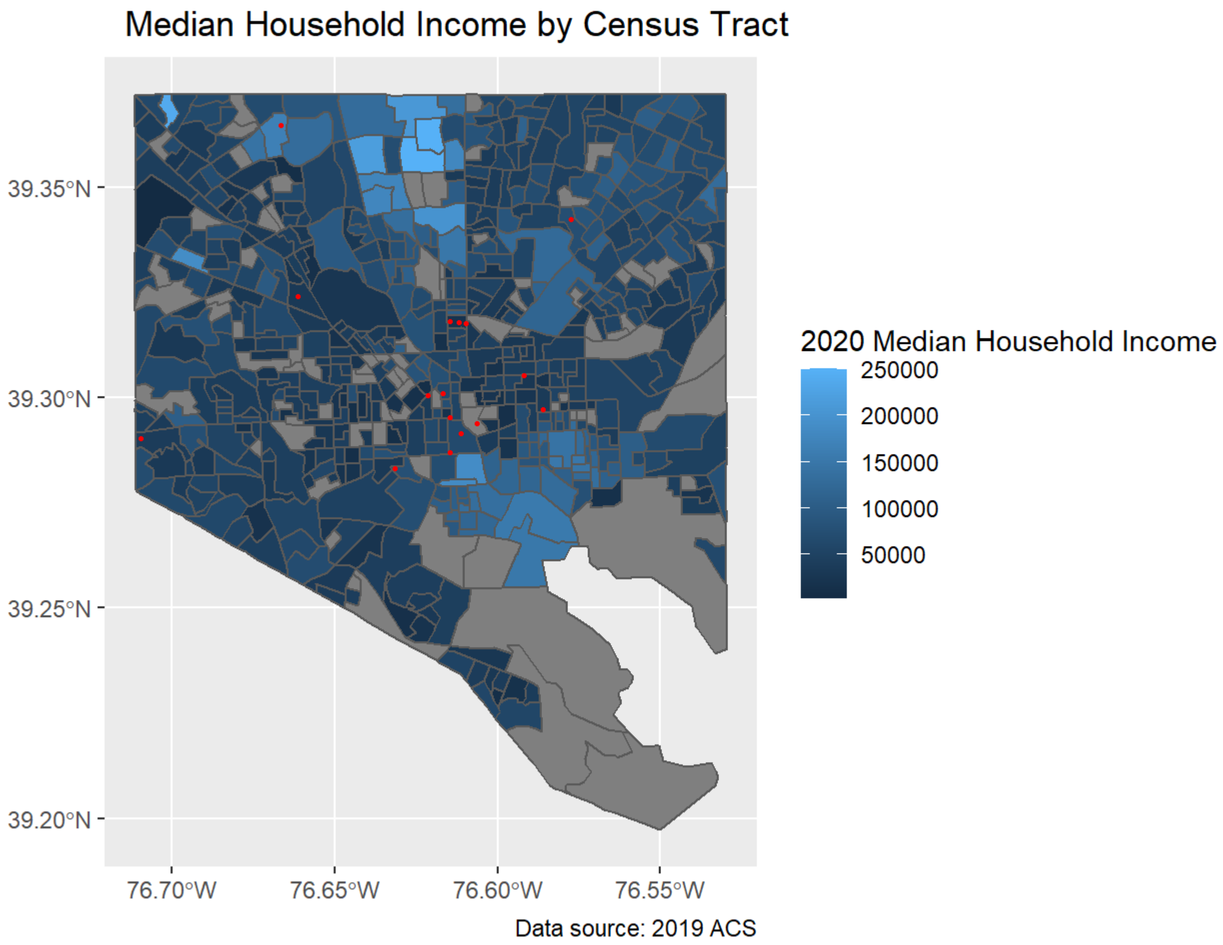
Map median household income by census block

```
ggplot(data = bal_MHI, aes(fill = estimate)) +

geom_sf()
```



Plot provider locations over median household income map

```
#create map of MHI with Naloxone points overlaid
bal_MHI_points <- ggplot() +
  geom_sf(data = bal_MHI, aes (fill = estimate)) +
  geom_sf(data = NarcanBalt_proj, fill = "red", color = "red", size = 0.6) +


  labs(title = "  Median Household Income by Census Tract ",
       caption = "Data source: 2019 ACS",
       fill = "2020 Median Household Income") +
  theme_gray()
bal_MHI_points
```



Median Household Income by Census Tract

Data source: 2019 ACS

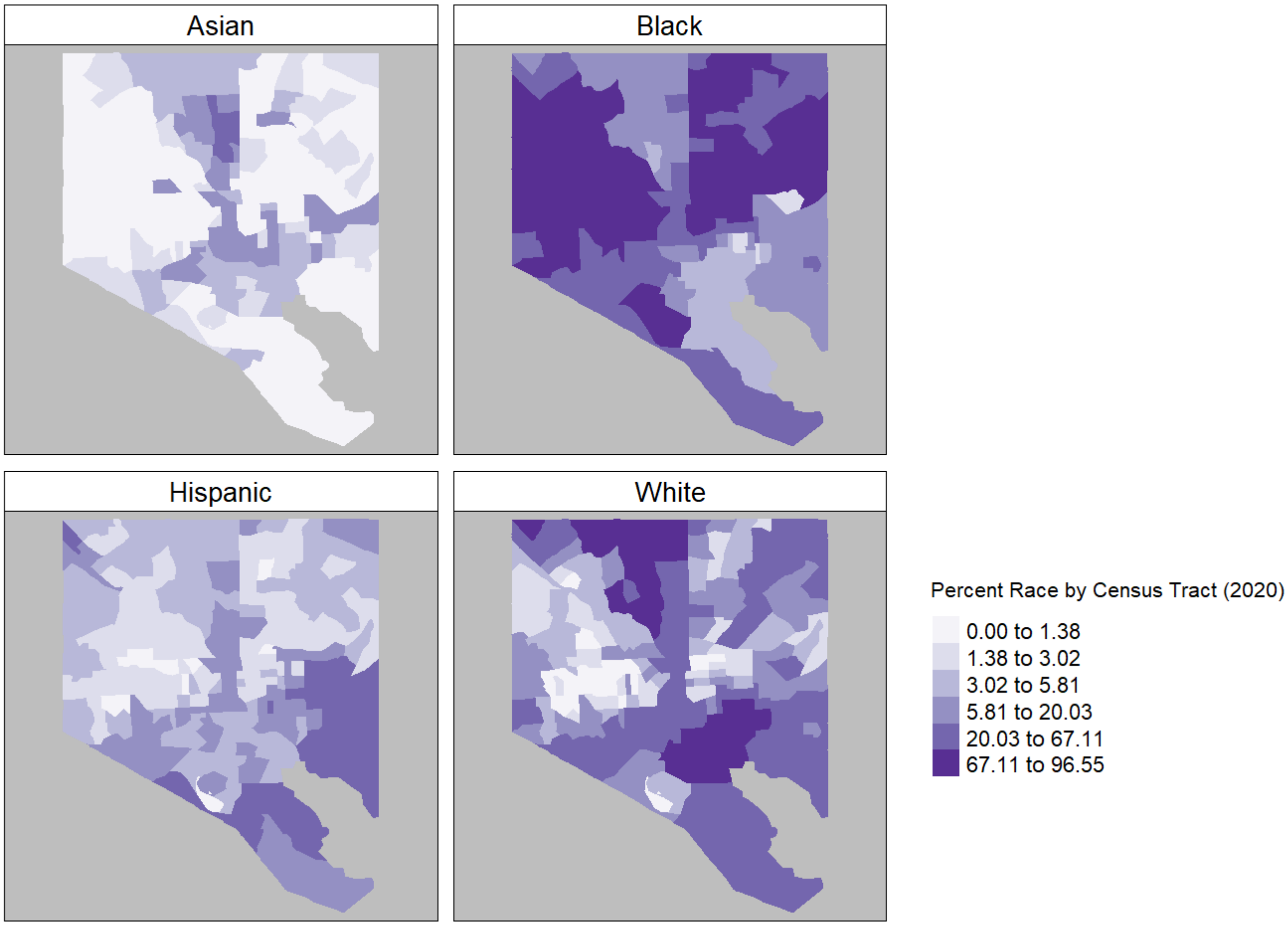
Create Faceted Map of Racial Demographics by Baltimore City Census Tracts

Get census racial data by census tract for year 2020

```
#get Census Race data by Census Tract
bal_race <- get_decennial(
  geography = "tract",
  state = "MD",
  county = "Baltimore City",
  variables = c(
    Hispanic = "P2_002N",
    White = "P2_005N",
    Black = "P2_006N",
    Asian = "P2_008N"
  ),
  summary_var = "P2_001N",
  year = 2020,
  geometry = TRUE
) %>%
  mutate(percent = 100 * (value / summary_value))
```

Plot the data as a faceted map, showing all 4 variables

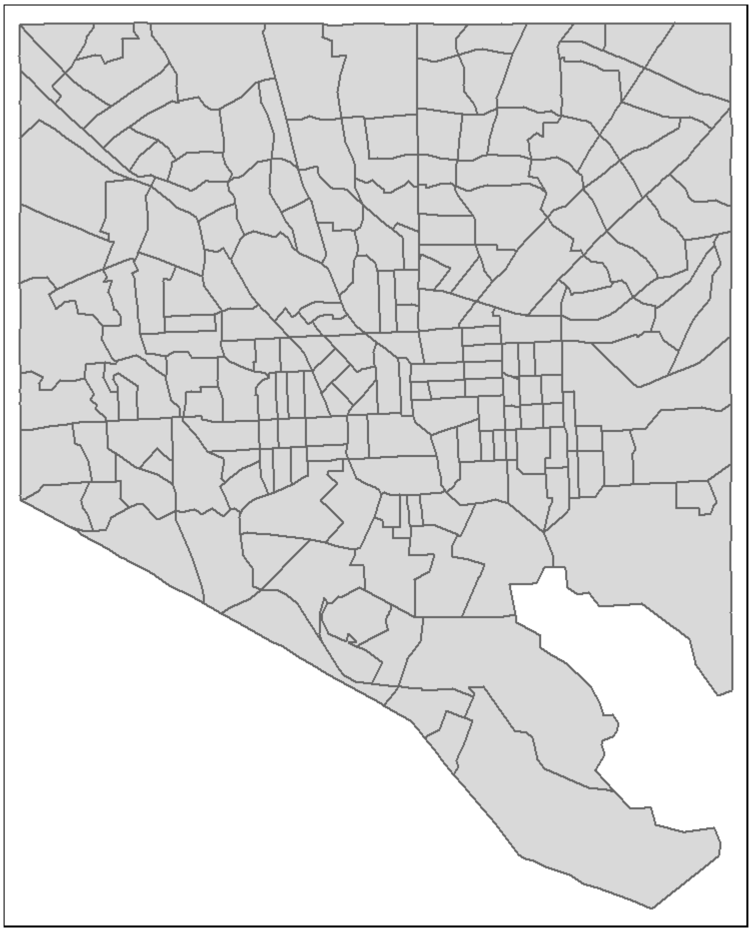
```
#create faceted map using tmap to show differences in racial distribution

tm_shape(bal_race) +
  tm_facets(by = "variable", scale.factor = 4) +
  tm_fill(col = "percent",
          style = "quantile",
          n = 6,
          palette = "Purples",
          title = "Percent Race by Census Tract (2020)") +
  tm_layout(bg.color = "grey",
            legend.position = c(0.1, 0.15),
            panel.label.bg.color = "white")
```



Map Provider locations and Percent Black/African American by Census tract

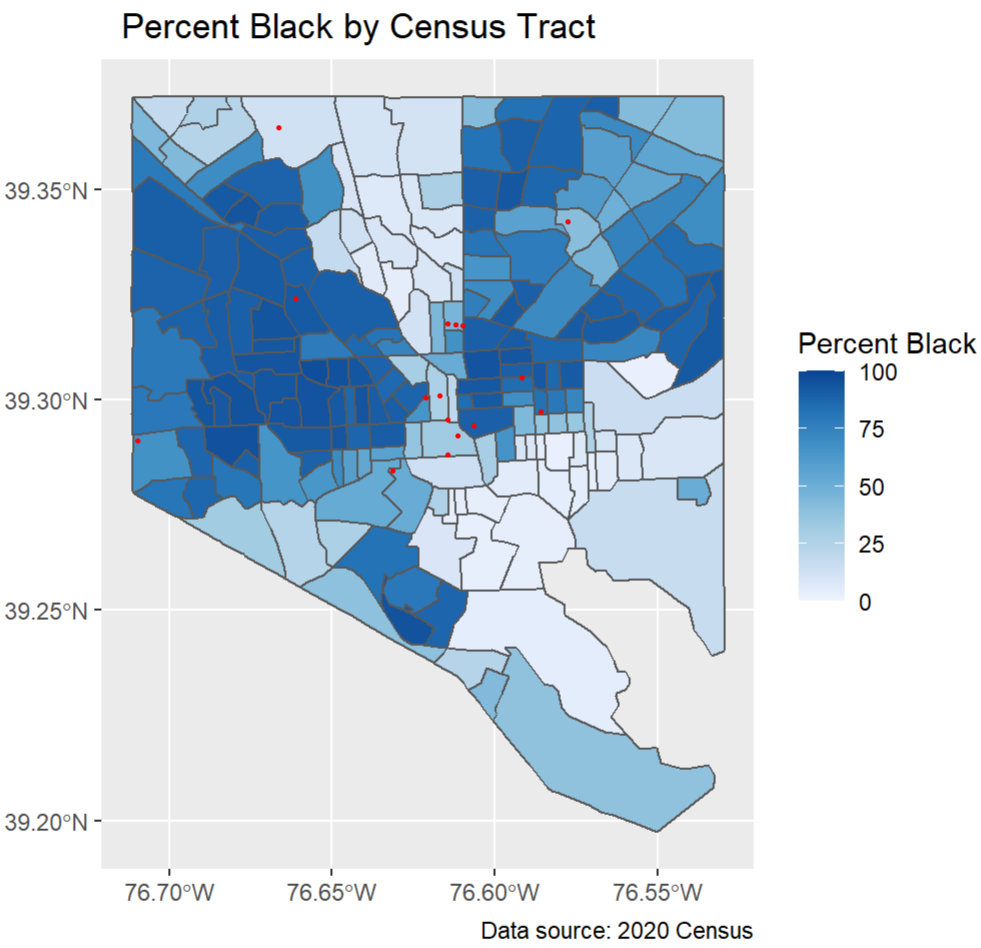
Using prior dataframe, use filter function to only select “Black”

```
#create maps of percent white and percent black by census tract with Naloxone points overlaid
bal_black <- filter(bal_race,
                         variable == "Black")

tm_shape(bal_black) +
  tm_polygons()
```



Create the map

```
#add legend and title, overlay Naloxone points
bal_black_points <- ggplot() +
  geom_sf(data = bal_black, aes (fill = percent)) +
  geom_sf(data = NarcanBalt_proj, fill = "red", color = "red", size = 0.6) +

   scale_fill_distiller(palette = "Blues",
                       direction = 0,
                       limits =c(0,100),
                       breaks=c(0,25,50,75,100)) +



  labs(title = "  Percent Black by Census Tract ",
       caption = "Data source: 2020 Census",
       fill = "Percent Black") +
  theme_gray()
bal_black_points
```



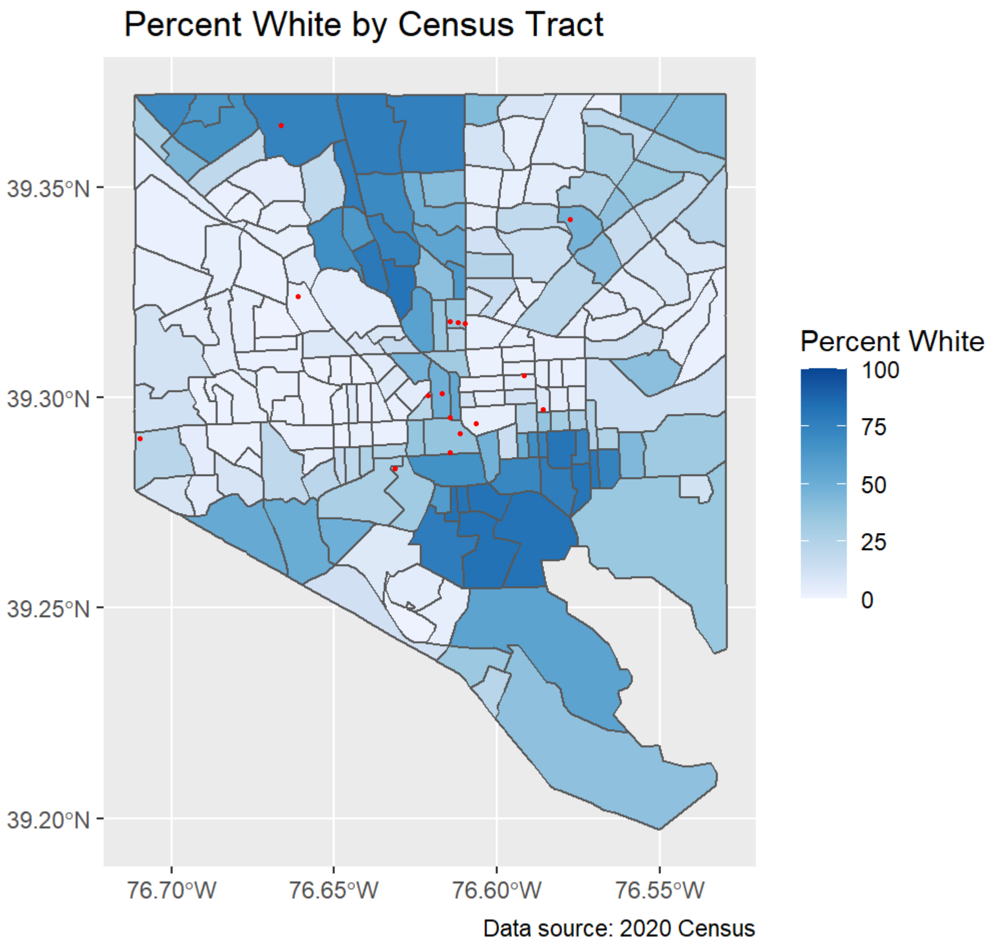
Mapping Provider locations and Percent White by Census Tract

Repeat same filter as before, but this time for “white” variable

```
#filter to get percent white by census tract
bal_white <- filter(bal_race,
                         variable == "White")
```

Recreate same map as before, only changing the variable

```
#Recreate previous map, excpet use percent white instead

#add legend and title, overlay Naloxone points
bal_white_points <- ggplot() +
  geom_sf(data = bal_white, aes (fill = percent)) +
  geom_sf(data = NarcanBalt_proj, fill = "red", color = "red", size = 0.6) +

   scale_fill_distiller(palette = "Blues",
                       direction = 0,
                       limits =c(0,100),
                       breaks=c(0,25,50,75,100)) +



  labs(title = "  Percent White by Census Tract ",
       caption = "Data source: 2020 Census",
       fill = "Percent White") +
  theme_gray()
bal_white_points
```



Calculating and Plotting Nearest Distance from CSA Centroid to Provider Location

Bring in Provider shapefile

```
#calculate distance from centroids of CSA to Naloxone locations
#first bring in Nalaxone provider shapefile
narcprovider <- st_read("./data/Balnarcan_points/Balnarcan_points.shp")
```

```
## Reading layer `Balnarcan_points' from data source 
##   `G:\My Drive\GES_486\Final_Project\data\Balnarcan_points\Balnarcan_points.shp' 
##   using driver `ESRI Shapefile'
## Simple feature collection with 16 features and 10 fields
## Geometry type: POINT
## Dimension:     XYZ
## Bounding box:  xmin: -76.70957 ymin: 39.28305 xmax: -76.57744 ymax: 39.3646
## z_range:       zmin: 0 zmax: 0
## Geodetic CRS:  WGS 84 + EGM96 height
```

Examine shapefile

```
head(narcprovider)
```

	O… <dbl>	Name <chr>
1	0	SWOP Baltimore
2	0	UMMC Midtown Campus Center for Addiction Medicine
3	0	Charm City Care Connection
4	0	SPARC Center JHU
5	0	BeSure
6	0	Project Connections at Behavioral Health Leadership Institute Inc.

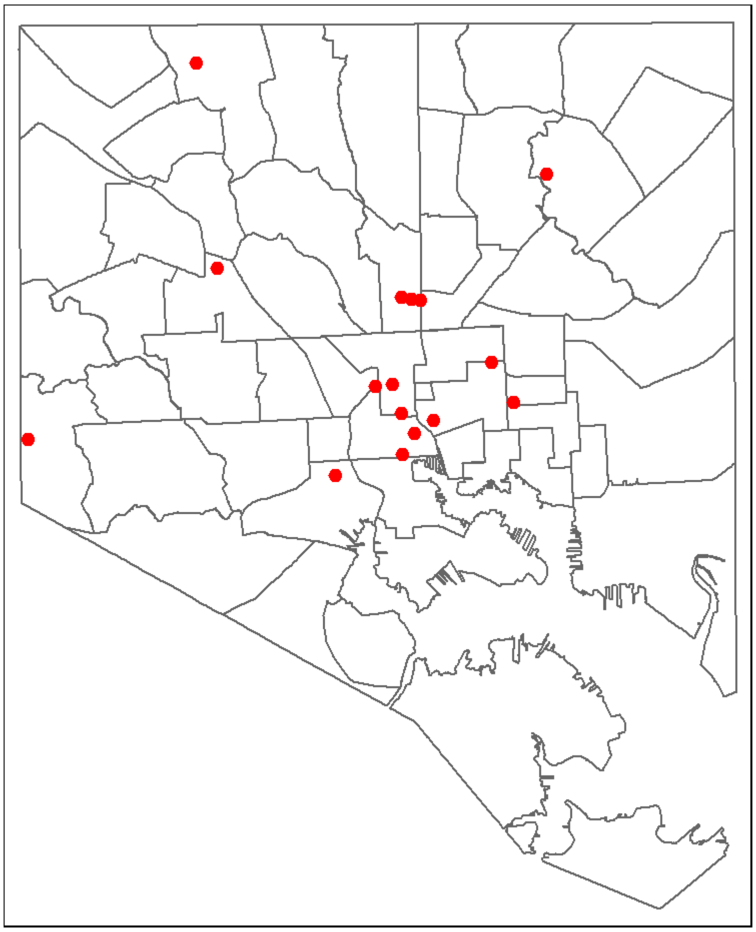
6 rows | 1-3 of 12 columns

Bring in CSA shapefile with overdose data

```
#next bring in shapefile of CSA's with overdose data

CSA_overdoses <- st_read("./data/Number_of_Overdose_Calls_for_Service_per_1%2C000_Residents (1)"
)
```

```
## Reading layer `Number_of_Overdose_Calls_for_Service_per_1%2C000_Residents' from data source `
G:\My Drive\GES_486\Final_Project\data\Number_of_Overdose_Calls_for_Service_per_1%2C000_Resident
s (1)'
##   using driver `ESRI Shapefile'
## Simple feature collection with 55 features and 8 fields
## Geometry type: MULTIPOLYGON
## Dimension:     XY
## Bounding box:  xmin: 1393927 ymin: 557733.6 xmax: 1445503 ymax: 621406.8
## Projected CRS: NAD83 / Maryland (ftUS)
```

```
#quick plot of both datasets

tm_shape(CSA_overdose) +
  tm_borders() +
tm_shape(narcprovider) +
  tm_dots(col = "red", size = 0.2)
```



Transform CSA shapefile to state plane ft

```
#calculate centroids of CSA
#first transform to MD state plane

CSA_overdose <- st_transform(CSA_overdose,6488)

CSA_overdose
```

	OBJEC... <int>	CSA2010 <chr>	overd18 <dbl>	overd19 <dbl>
1	1	Allendale/Irvington/S. Hilton	3.6381575	5.4264044
2	2	Beechfield/Ten Hills/West Hills	2.0384866	3.9138943
3	3	Belair-Edison	3.1580156	2.9857602
4	4	Brooklyn/Curtis Bay/Hawkins Point	14.6036650	14.2526153
5	5	Canton	1.2345679	2.4691358
6	6	Cedonia/Frankford	2.4196629	2.2923123
7	7	Cherry Hill	5.3645452	6.5837601
8	8	Chinquapin Park/Belvedere	3.6101083	2.5786488

	OBJEC… <int>	CSA2010 <chr>	overd18 <dbl>	overd19 <dbl>	▶
9	9	Claremont/Armistead	4.2522172	4.9811688	
10	10	Clifton-Berea	10.7352643	15.3939639	

1-10 of 55 rows | 1-5 of 10 columns Previous **1** 2 3 4 5 6 Next

Calculate centroids

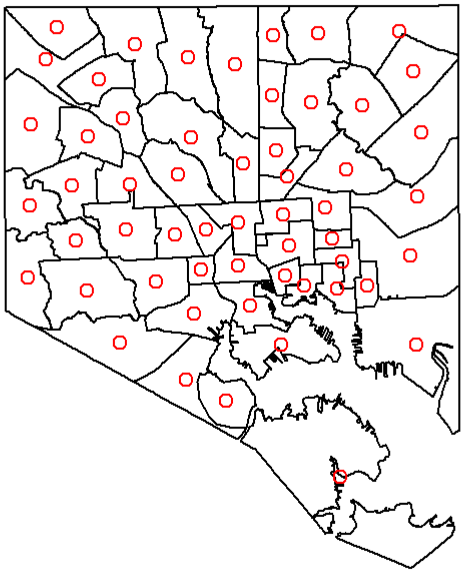
```
#now calculate the cetroids
CSA_centroids <- st_centroid(CSA_overdose)



CSA_centroids
```

	OBJEC… <int>	CSA2010 <chr>	overd18 <dbl>	overd19 <dbl>	▶
1	1	Allendale/Irvington/S. Hilton	3.6381575	5.4264044	
2	2	Beechfield/Ten Hills/West Hills	2.0384866	3.9138943	
3	3	Belair-Edison	3.1580156	2.9857602	
4	4	Brooklyn/Curtis Bay/Hawkins Point	14.6036650	14.2526153	
5	5	Canton	1.2345679	2.4691358	
6	6	Cedonia/Frankford	2.4196629	2.2923123	
7	7	Cherry Hill	5.3645452	6.5837601	
8	8	Chinquapin Park/Belvedere	3.6101083	2.5786488	
9	9	Claremont/Armistead	4.2522172	4.9811688	
10	10	Clifton-Berea	10.7352643	15.3939639	

1-10 of 55 rows | 1-5 of 10 columns Previous **1** 2 3 4 5 6 Next

Plot results

```
plot(st_geometry(CSA_overdose))
plot(st_geometry(CSA_centroids), add = TRUE, col = "red")
```



Transfrom provider location shapefile to state plane ft

```
narc_transform <- st_transform(narcprovider, 6488)
```

Calculate distance from centroids to provider locations

```
#calculate distance from centroids to providers
st_distance(CSA_centroids,narc_transform, by_element = TRUE)
```

```
## Units: [US_survey_foot]
##  [1] 35623.564 23354.558  7553.446 25785.603 12423.059 36347.950 13851.726
##  [8] 16599.565 18024.316 10380.367 27546.775 27582.094  5525.332  9387.956
## [15]  8191.593  7438.118 31700.141 28952.814  9520.514 23643.890 13842.376
## [22]  8598.948 14899.522  5086.041 21417.940  3534.638 24115.225 11695.744
## [29] 11942.211 10217.724 44046.299 26226.936 15571.758 12093.635  7470.585
## [36] 16170.299 18415.435  2618.306 24406.358 11102.264  8019.720 17579.153
## [43] 14262.382 13870.312  9929.778 13537.160 19161.220 10963.457 28814.801
## [50] 18060.589 18088.652 18000.628  4010.257 33175.069 13216.514
```

Calculate nearest index

```
#calculating nearest index

nearest_narc_indexes <- st_nearest_feature(CSA_centroids,narc_transform)


nearest_narc <- narc_transform[nearest_narc_indexes,]

nearest_narc
```

	O…	Name
	<dbl>	<chr>
15	0	Baltimore City Crisis Response Inc.
15.1	0	Baltimore City Crisis Response Inc.
3	0	Charm City Care Connection
7	0	Behavioral Health System Baltimore
14	0	Lighthouse Studies at Peer Point
1	0	SWOP Baltimore
4	0	SPARC Center JHU
1.1	0	SWOP Baltimore
14.1	0	Lighthouse Studies at Peer Point
3.1	0	Charm City Care Connection

1-10 of 55 rows | 1-3 of 12 columns Previous **1** 2 3 4 5 6 Next

Calculate distance betweeen CSA centroid and nearest provider

```
#calculate distance between CSA centroid and nearest Naloxone provider

minDist <- st_distance(CSA_centroids,nearest_narc, by_element = TRUE)


minDist
```

```
## Units: [US_survey_foot]
##  [1]  9079.768  2220.291  7553.446 24606.155  5178.318  9908.628 12384.598
##  [8] 10570.564 12557.565  2925.641  6722.827  7635.910  5525.332  1776.913
## [15]  8191.593  4636.343  7121.094  8604.183  1927.786  7633.481  2610.858
## [22]  8598.948  7706.470  2485.451  9014.648  2797.112 10498.423  7043.917
## [29] 11942.211  2969.343  2648.598  8107.863  1796.673  7442.703  1400.145
## [36]  3256.075 11203.064  2618.306 12530.527  3119.105  2874.257 10440.022
## [43]  3236.648  5625.540  5854.526  2627.730  6232.599  8219.942 15632.848
## [50]  4958.726  5716.896  3988.440  2815.166  2620.631 10009.914
```

Change feet into miles as it is more logical

```
#change feet to miles
minDist_mi <- set_units(minDist,"mi")
minDist_mi
```

```
## Units: [mi]
##  [1] 1.7196564 0.4205105 1.4305798 4.6602660 0.9807440 1.8766378 2.3455725
##  [8] 2.0020048 2.3783314 0.5540998 1.2732652 1.4461980 1.0464664 0.3365372
## [15] 1.5514412 0.8780971 1.3486948 1.6295833 0.3651118 1.4457380 0.4944817
## [22] 1.6285920 1.4595616 0.4707303 1.7073230 0.5297571 1.9883417 1.3340779
## [29] 2.2617870 0.5623767 0.5016294 1.5355832 0.3402796 1.4096057 0.2651795
## [36] 0.6166821 2.1217966 0.4958922 2.3732106 0.5907408 0.5443680 1.9772809
## [43] 0.6130027 1.0654454 1.1088140 0.4976771 1.1804189 1.5568103 2.9607726
## [50] 0.9391545 1.0827475 0.7553878 0.5331764 0.4963327 1.8958209
```

Bind minimum distance to provider from centroid to CSA shapefile

```
#bind min distance to the CSA_overdose shapefile

minDistSf <- cbind(CSA_overdose, minDist_mi)


minDistSf
```

	OBJEC…	CSA2010	overd18	overd19	▸
	<int>	<chr>	<dbl>	<dbl>	
1	1	Allendale/Irvington/S. Hilton	3.6381575	5.4264044	
2	2	Beechfield/Ten Hills/West Hills	2.0384866	3.9138943	
3	3	Belair-Edison	3.1580156	2.9857602	
4	4	Brooklyn/Curtis Bay/Hawkins Point	14.6036650	14.2526153	
5	5	Canton	1.2345679	2.4691358	
6	6	Cedonia/Frankford	2.4196629	2.2923123	
7	7	Cherry Hill	5.3645452	6.5837601	
8	8	Chinquapin Park/Belvedere	3.6101083	2.5786488	
9	9	Claremont/Armistead	4.2522172	4.9811688	
10	10	Clifton-Berea	10.7352643	15.3939639	

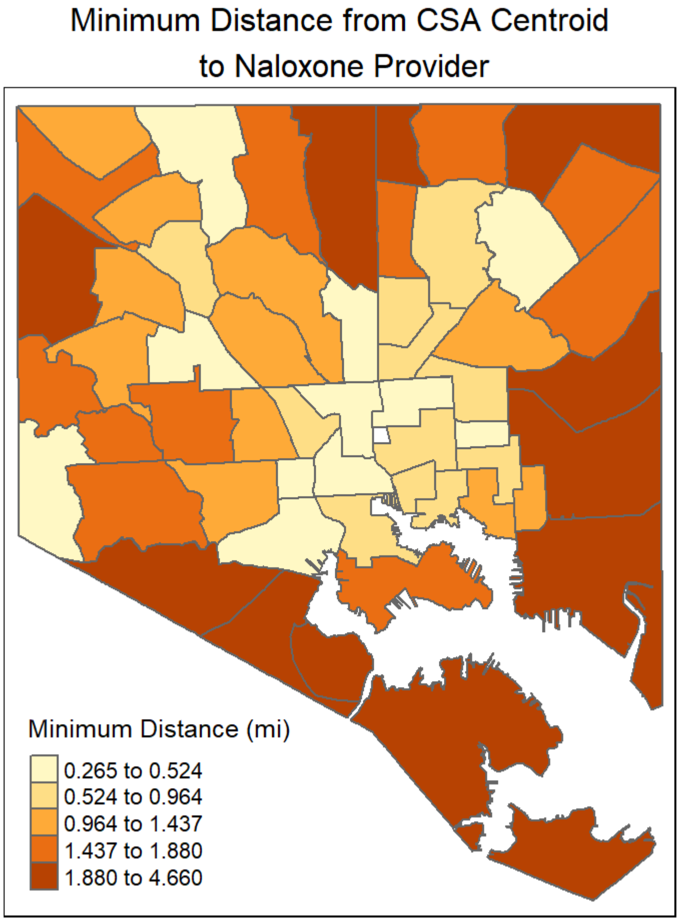
1-10 of 55 rows | 1-5 of 11 columns Previous **1** 2 3 4 5 6 Next

set tmap mode to “plot”

```
#visualize Naloxone access using tmap

tmap_mode("plot")
```

Create a map showing minimum distance from CSA centroid to provider.

```
tm_shape(minDistSf) +
  tm_polygons("minDist_mi", style = "quantile", n=5,
              title = "Minimum Distance (mi)") +
  tm_layout(main.title = "Minimum Distance from CSA Centroid\n to Naloxone Provider",
            main.title.position = "center",
            main.title.size = 1)
```


Minimum Distance from CSA Centroid
to Naloxone Provider
Minimum Distance (mi)
0.265 to 0.524
0.524 to 0.964
0.964 to 1.437
1.437 to 1.880
1.880 to 4.660