

Census Data, Leaflet, and more Choropleths

Data Wrangling and Husbandry

03/30/2020

The `choroplethr` package works well, but you

1. are likely to want data beyond the examples in the package
2. might want to integrate the maps into `ggplot2`
3. might want to create `leaflet` maps

Census Data

- ▶ The United States Bureau of the Census
 - ▶ performs the US Census every 10 years
 - ▶ runs many other survey and censuses, of which the most important is the American Community Survey
- ▶ To work with census data, you will want an API key
 - ▶ https://api.census.gov/data/key_signup.html
- ▶ Within R, the `acs` package or the `tidycensus` make working with census data much easier.

You can save your api key within a session using this format

```
library(tidycensus)
library(tidyverse)

census_api_key("YOUR API KEY GOES HERE")
```

To install your API key for use in future sessions, run

- ▶ The ACS uses coded names for variables, and they change over time.
- ▶ The most recent ACS aggregated over 5 years is 2016.

- ▶ You can look up variable names at

https://www.socialexplorer.com/data/ACS2016_5yr/metadata
(and many other places)

- ▶ You can use the `load_variables()` function in the `tidycensus` package as well, although I'm not certain it gets all of the variables.

```
v15 <- load_variables(2016, "acs5", cache = TRUE)
View(v15)
```

- ▶ You'll notice that the ACS includes both estimates and margins of error; the variable names end in E or M. When we download variables using `get_acs()` we drop the letter at the end.

Median household income example

```
nj_median_household_income <-  
  get_acs(geography = "county",  
          variables = c(medincome = "B19013_001"),  
          state = "NJ")
```

```
## Getting data from the 2014-2018 5-year ACS
```

```
glimpse(nj_median_household_income)
```

```
## Observations: 21
```

```
## Variables: 5
```

```
## $ GEOID      <chr> "34001", "34003", "34005", "34007", "34009"
```

```
## $ NAME       <chr> "Atlantic County, New Jersey", "Bergen County, New Jersey", "Butler County, New Jersey"
```

```
## $ variable   <chr> "medincome", "medincome", "medincome", "medincome", "medincome"
```

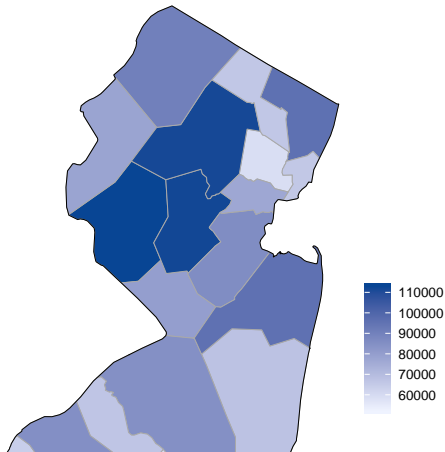
```
## $ estimate   <dbl> 59989, 95837, 84992, 67118, 63690, 52599, 48999, 45999, 42999, 39999, 36999, 33999, 30999, 27999, 24999, 21999, 18999, 15999, 12999, 9999, 6999, 3999, 999
```

```
## $ moe        <dbl> 1631, 998, 1319, 1282, 1641, 1718, 1069, 1131, 1201, 1271, 1341, 1411, 1481, 1551, 1621, 1691, 1761, 1831, 1901, 1971, 2041, 2111, 2181, 2251, 2321, 2391, 2461, 2531, 2601, 2671, 2741, 2811, 2881, 2951, 3021, 3091, 3161, 3231, 3301, 3371, 3441, 3511, 3581, 3651, 3721, 3791, 3861, 3931, 4001, 4071, 4141, 4211, 4281, 4351, 4421, 4491, 4561, 4631, 4701, 4771, 4841, 4911, 4981, 5051, 5121, 5191, 5261, 5331, 5401, 5471, 5541, 5611, 5681, 5751, 5821, 5891, 5961, 6031, 6101, 6171, 6241, 6311, 6381, 6451, 6521, 6591, 6661, 6731, 6801, 6871, 6941, 7011, 7081, 7151, 7221, 7291, 7361, 7431, 7501, 7571, 7641, 7711, 7781, 7851, 7921, 7991, 8061, 8131, 8201, 8271, 8341, 8411, 8481, 8551, 8621, 8691, 8761, 8831, 8901, 8971, 9041, 9111, 9181, 9251, 9321, 9391, 9461, 9531, 9601, 9671, 9741, 9811, 9881, 9951, 10021, 10091, 10161, 10231, 10301, 10371, 10441, 10511, 10581, 10651, 10721, 10791, 10861, 10931, 11001, 11071, 11141, 11211, 11281, 11351, 11421, 11491, 11561, 11631, 11701, 11771, 11841, 11911, 11981, 12051, 12121, 12191, 12261, 12331, 12401, 12471, 12541, 12611, 12681, 12751, 12821, 12891, 12961, 13031, 13101, 13171, 13241, 13311, 13381, 13451, 13521, 13591, 13661, 13731, 13801, 13871, 13941, 14011, 14081, 14151, 14221, 14291, 14361, 14431, 14501, 14571, 14641, 14711, 14781, 14851, 14921, 14991, 15061, 15131, 15201, 15271, 15341, 15411, 15481, 15551, 15621, 15691, 15761, 15831, 15901, 15971, 16041, 16111, 16181, 16251, 16321, 16391, 16461, 16531, 16601, 16671, 16741, 16811, 16881, 16951, 17021, 17091, 17161, 17231, 17301, 17371, 17441, 17511, 17581, 17651, 17721, 17791, 17861, 17931, 18001, 18071, 18141, 18211, 18281, 18351, 18421, 18491, 18561, 18631, 18701, 18771, 18841, 18911, 18981, 19051, 19121, 19191, 19261, 19331, 19401, 19471, 19541, 19611, 19681, 19751, 19821, 19891, 19961, 20031, 20101, 20171, 20241, 20311, 20381, 20451, 20521, 20591, 20661, 20731, 20801, 20871, 20941, 21011, 21081, 21151, 21221, 21291, 21361, 21431, 21501, 21571, 21641, 21711, 21781, 21851, 21921, 21991, 22061, 22131, 22201, 22271, 22341, 22411, 22481, 22551, 22621, 22691, 22761, 22831, 22901, 22971, 23041, 23111, 23181, 23251, 23321, 23391, 23461, 23531, 23601, 23671, 23741, 23811, 23881, 23951, 24021, 24091, 24161, 24231, 24301, 24371, 24441, 24511, 24581, 24651, 24721, 24791, 24861, 24931, 25001, 25071, 25141, 25211, 25281, 25351, 25421, 25491, 25561, 25631, 25701, 25771, 25841, 25911, 25981, 26051, 26121, 26191, 26261, 26331, 26401, 26471, 26541, 26611, 26681, 26751, 26821, 26891, 26961, 27031, 27101, 27171, 27241, 27311, 27381, 27451, 27521, 27591, 27661, 27731, 27801, 27871, 27941, 28011, 28081, 28151, 28221, 28291, 28361, 28431, 28501, 28571, 28641, 28711, 28781, 28851, 28921, 28991, 29061, 29131, 29201, 29271, 29341, 29411, 29481, 29551, 29621, 29691, 29761, 29831, 29901, 29971, 30041, 30111, 30181, 30251, 30321, 30391, 30461, 30531, 30601, 30671, 30741, 30811, 30881, 30951, 31021, 31091, 31161, 31231, 31301, 31371, 31441, 31511, 31581, 31651, 31721, 31791, 31861, 31931, 32001, 32071, 32141, 32211, 32281, 32351, 32421, 32491, 32561, 32631, 32701, 32771, 32841, 32911, 32981, 33051, 33121, 33191, 33261, 33331, 33401, 33471, 33541, 33611, 33681, 33751, 33821, 33891, 33961, 34031, 34101, 34171, 34241, 34311, 34381, 34451, 34521, 34591, 34661, 34731, 34801, 34871, 34941, 35011, 35081, 35151, 35221, 35291, 35361, 35431, 35501, 35571, 35641, 35711, 35781, 35851, 35921, 35991, 36061, 36131, 36201, 36271, 36341, 36411, 36481, 36551, 36621, 36691, 36761, 36831, 36901, 36971, 37041, 37111, 37181, 37251, 37321, 37391, 37461, 37531, 37601, 37671, 37741, 37811, 37881, 37951, 38021, 38091, 38161, 38231, 38301, 38371, 38441, 38511, 38581, 38651, 38721, 38791, 38861, 38931, 39001, 39071, 39141, 39211, 39281, 39351, 39421, 39491, 39561, 39631, 39701, 39771, 39841, 39911, 39981, 40051, 40121, 40191, 40261, 40331, 40401, 40471, 40541, 40611, 40681, 40751, 40821, 40891, 40961, 41031, 41101, 41171, 41241, 41311, 41381, 41451, 41521, 41591, 41661, 41731, 41801, 41871, 41941, 42011, 42081, 42151, 42221, 42291, 42361, 42431, 42501, 42571, 42641, 42711, 42781, 42851, 42921, 42991, 43061, 43131, 43201, 43271, 43341, 43411, 43481, 43551, 43621, 43691, 43761, 43831, 43901, 43971, 44041, 44111, 44181, 44251, 44321, 44391, 44461, 44531, 44601, 44671, 44741, 44811, 44881, 44951, 45021, 45091, 45161, 45231, 45301, 45371, 45441, 45511, 45581, 45651, 45721, 45791, 45861, 45931, 46001, 46071, 46141, 46211, 46281, 46351, 46421, 46491, 46561, 46631, 46701, 46771, 46841, 46911, 46981, 47051, 47121, 47191, 47261, 47331, 47401, 47471, 47541, 47611, 47681, 47751, 47821, 47891, 47961, 48031, 48101, 48171, 48241, 48311, 48381, 48451, 48521, 48591, 48661, 48731, 48801, 48871, 48941, 49011, 49081, 49151, 49221, 49291, 49361, 49431, 49501, 49571, 49641, 49711, 49781, 49851, 49921, 49991, 50061, 50131, 50201, 50271, 50341, 50411, 50481, 50551, 50621, 50691, 50761, 50831, 50901, 50971, 51041, 51111, 51181, 51251, 51321, 51391, 51461, 51531, 51601, 51671, 51741, 51811, 51881, 51951, 52021, 52091, 52161, 52231, 52301, 52371, 52441, 52511, 52581, 52651, 52721, 52791, 52861, 52931, 53001, 53071, 53141, 53211, 53281, 53351, 53421, 53491, 53561, 53631, 53701, 53771, 53841, 53911, 53981, 54051, 54121, 54191, 54261, 54331, 54401, 54471, 54541, 54611, 54681, 54751, 54821, 54891, 54961, 55031, 55101, 55171, 55241, 55311, 55381, 55451, 55521, 55591, 55661, 55731, 55801, 55871, 55941, 56011, 56081, 56151, 56221, 56291, 56361, 56431, 56501, 56571, 56641, 56711, 56781, 56851, 56921, 56991, 57061, 57131, 57201, 57271, 57341, 57411, 57481, 57551, 57621, 57691, 57761, 57831, 57901, 57971, 58041, 58111, 58181, 58251, 58321, 58391, 58461, 58531, 58601, 58671, 58741, 58811, 58881, 58951, 59021, 59091, 59161, 59231, 59301, 59371, 59441, 59511, 59581, 59651, 59721, 59791, 59861, 59931, 60001, 60071, 60141, 60211, 60281, 60351, 60421, 60491, 60561, 60631, 60701, 60771, 60841, 60911, 60981, 61051, 61121, 61191, 61261, 61331, 61401, 61471, 61541, 61611, 61681, 61751, 61821, 61891, 61961, 62031, 62101, 62171, 62241, 62311, 62381, 62451, 62521, 62591, 62661, 62731, 62801, 62871, 62941, 63011, 63081, 63151, 63221, 63291, 63361, 63431, 63501, 63571, 63641, 63711, 63781, 63851, 63921, 63991, 64061, 64131, 64201, 64271, 64341, 64411, 64481, 64551, 64621, 64691, 64761, 64831, 64901, 64971, 65041, 65111, 65181, 65251, 65321, 65391, 65461, 65531, 65601, 65671, 65741, 65811, 65881, 65951, 66021, 66091, 66161, 66231, 66301, 66371, 66441, 66511, 66581, 66651, 66721, 66791, 66861, 66931, 67001, 67071, 67141, 67211, 67281, 67351, 67421, 67491, 67561, 67631, 67701, 67771, 67841, 67911, 67981, 68051, 68121, 68191, 68261, 68331, 68401, 68471, 68541, 68611, 68681, 68751, 68821, 68891, 68961, 69031, 69101, 69171, 69241, 69311, 69381, 69451, 69521, 69591, 69661, 69731, 69801, 69871, 69941, 70011, 70081, 70151, 70221, 70291, 70361, 70431, 70501, 70571, 70641, 70711, 70781, 70851, 70921, 70991, 71061, 71131, 71201, 71271, 71341, 71411, 71481, 71551, 71621, 71691, 71761, 71831, 71901, 71971, 72041, 72111, 72181, 72251, 72321, 72391, 72461, 72531, 72601, 72671, 72741, 72811, 72881, 72951, 73021, 73091, 73161, 73231, 73301, 73371, 73441, 73511, 73581, 73651, 73721, 73791, 73861, 73931, 74001, 74071, 74141, 74211, 74281, 74351, 74421, 74491, 74561, 74631, 74701, 74771, 74841, 74911, 74981, 75051, 75121, 75191, 75261, 75331, 75401, 75471, 75541, 75611, 75681, 75751, 75821, 75891, 75961, 76031, 76101, 76171, 76241, 76311, 76381, 76451, 76521, 76591, 76661, 76731, 76801, 76871, 76941, 77011, 77081, 77151, 77221, 77291, 77361, 77431, 77501, 77571, 77641, 77711, 77781, 77851, 77921, 77991, 78061, 78131, 78201, 78271, 78341, 78411, 78481, 78551, 78621, 78691, 78761, 78831, 78901, 78971, 79041, 79111, 79181, 79251, 79321, 79391, 79461, 79531, 79601, 79671, 79741, 79811, 79881, 79951, 80021, 80091, 80161, 80231, 80301, 80371, 80441, 80511, 80581, 80651, 80721, 80791, 80861, 80931, 81001, 81071, 81141, 81211, 81281, 81351, 81421, 81491, 81561, 81631, 81701, 81771, 81841, 81911, 81981, 82051, 82121, 82191, 82261, 82331, 82401, 82471, 82541, 82611, 82681, 82751, 82821, 82891, 82961, 83031, 83101, 83171, 83241, 83311, 83381, 83451, 83521, 83591, 83661, 83731, 83801, 83871, 83941, 84011, 84081, 84151, 84221, 84291, 84361, 84431, 84501, 84571, 84641, 84711, 84781, 84851, 84921, 84991, 85061, 85131, 85201, 85271, 85341, 85411, 85481, 85551, 85621, 85691, 85761, 85831, 85901, 85971, 86041, 86111, 86181, 86251, 86321, 86391, 86461, 86531, 86601, 86671, 86741, 86811, 86881, 86951, 87021, 87091, 87161, 87231, 87301, 87371, 87441, 87511, 87581, 87651, 87721, 87791, 87861, 87931, 88001, 88071, 88141, 88211, 88281, 88351, 88421, 88491, 88561, 88631, 88701, 88771, 88841, 88911, 88981, 89051, 89121, 89191, 89261, 89331, 89401, 89471, 89541, 89611, 89681, 89751, 89821, 89891, 89961, 90031, 90101, 90171, 90241, 90311, 90381, 90451, 90521, 90591, 90661, 90731, 90801, 90871, 90941, 91011, 91081, 91151, 91221, 91291, 91361, 91431, 91501, 91571, 91641, 91711, 91781, 91851, 91921, 91991, 92061, 92131, 92201, 92271, 92341, 92411, 92481, 92551, 92621, 92691, 92761, 92831, 92901, 92971, 93041, 93111, 93181, 93251, 93321, 93391, 93461, 93531, 93601, 93671, 93741, 93811, 93881, 93951, 94021, 94091, 94161, 94231, 94301, 94371, 94441, 94511, 94581, 94651, 94721, 94791, 94861, 94931, 95001, 95071, 95141, 95211, 95281, 95351, 95421, 95491, 95561, 95631, 95701, 95771, 95841, 95911, 95981, 96051, 96121, 96191, 96261, 96331, 96401, 96471, 96541, 96611, 96681, 96751, 96821, 96891, 96961, 97031, 97101, 97171, 97241, 97311, 97381, 97451, 97521, 97591, 97661, 97731, 97801, 97871, 97941, 98011, 98081, 98151, 98221, 98291, 98361, 98431, 98501, 98571, 98641, 98711, 98781, 98851, 98921, 98991, 99061, 99131, 99201, 99271, 99341, 99411, 99481, 99551, 99621, 99691, 99761, 99831, 99901, 99971, 100041, 100111, 100181, 100251, 100321, 100391, 100461, 100531, 100601, 100671, 100741, 100811, 100881, 100951, 101021, 101091, 101161, 101231, 101301, 101371, 101441, 101511, 101581, 101651, 101721, 101791, 101861, 101931, 102001, 102071, 102141, 102211, 102281, 102351, 102421, 102491, 102561, 102631, 102701, 102771, 102841, 102911, 102981, 103051, 103121, 103191, 103261, 103331, 103401, 103471, 103541, 103611, 103681, 103751, 103821, 103891, 103961, 104031, 104101, 104171, 104241, 104311, 104381, 104451, 104521, 104591, 104661, 104731, 104801, 104871, 104941, 105011, 105081, 105151, 105221, 105291, 105361, 105431, 105501, 105571, 105641, 105711, 105781, 105851, 105921, 105991, 106061, 106131, 106201, 106271, 106341, 106411, 106481, 106551, 106621, 106691, 106761, 106831, 106901, 106971, 107041, 107111, 107181, 107251, 107321, 107391, 107461, 107531, 107601, 107671, 107741, 107811, 107881, 107951, 108021, 108091, 108161, 108231, 108301, 108371, 108441, 108511, 108581, 108651, 108721, 108791, 108861, 108931, 109001, 109071, 109141, 109211, 109281, 109351, 109421, 109491, 109561, 109631, 109701, 109771, 109841, 109911, 109981, 110051, 110121, 110191, 110261, 110331, 110401, 110471, 110541, 110611, 110681, 110751, 110821, 110891, 110961, 111031, 111101, 111171, 111241, 111311, 111381, 111451, 111521, 111591, 111661, 111731, 111801, 111871, 111941, 112011, 112081, 112151, 112221, 112291, 112361, 112431, 112501, 112571, 112641, 112711, 112781, 112851, 112921, 112991, 113061, 113131, 113201, 113271, 113341, 113411, 113481, 113551, 113621, 113691, 113761, 113831, 113901, 113971, 114041, 114111, 114181, 114251, 114321, 114391, 114461, 114531, 114601, 114671, 114741, 114811, 114881, 114951, 115021, 115091, 115161, 115231, 115301, 115371, 115441, 115511, 115581, 115651, 115721, 115791, 115861, 115931, 116001, 116071, 11614
```

We could pipe this to the function from the `cloroplethr` package:

```
nj_median_household_income %>%  
  dplyr::rename(value = estimate) %>%  
  mutate(region = as.integer(GEOID)) %>%  
  choroplethr::county_choropleth(title = "Median Household
```

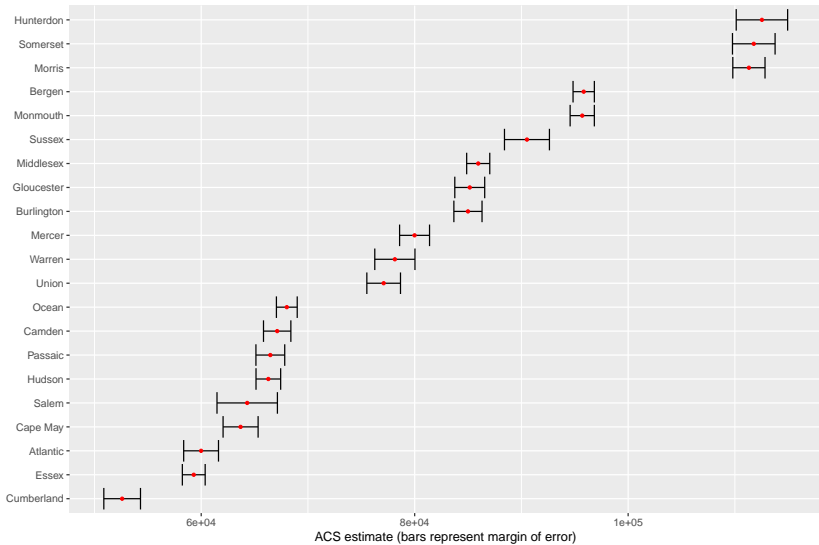
Median Household Income



Not every use of census data has to be a map.

```
nj_median_household_income %>%  
  mutate(NAME = str_replace(NAME, " County, New Jersey", ""))  
  mutate(NAME = reorder(NAME, estimate)) %>%  
  ggplot(aes(x = estimate, y = NAME)) +  
  geom_errorbarh(aes(xmin = estimate - moe, xmax = estimate + moe))  
  geom_point(color = "red", size = 1) +  
  labs(title = "Household income by county in NJ",  
        subtitle = "2012-2016 American Community Survey",  
        y = "",  
        x = "ACS estimate (bars represent margin of error)")
```


Household income by county in NJ 2012–2016 American Community Survey



- ▶ ACS data is reported on finer geographic units than states and counties, known as “tracts”:

```
## Change geography to "tract"  
## and add geometry = TRUE for plotting purposes  
  
nj_median_household_income2 <-  
  get_acs(geography = "tract",  
          variables = c(medincome = "B19013_001"),  
          state = "NJ",  
          geometry = TRUE)
```

```
## Getting data from the 2014-2018 5-year ACS
```

```
## Downloading feature geometry from the Census website. T
```

```
## |
```

```
glimpse(nj_median_household_income2)
```

```
## Observations: 2,010
```

```
## Variables: 6
```

```
## $ GEOID      <chr> "34001000100", "34001000200", "34001000
```

```
## $ NAME       <chr> "Census Tract 1, Atlantic County, New J
```

```
## $ variable   <chr> "medincome", "medincome", "medincome",
```

```
## $ estimate   <dbl> 34844, 46742, 36827, 31115, 38054, 1469
```

```
## $ moe        <dbl> 3888, 18150, 6976, 9120, 4308, 2249, 65
```

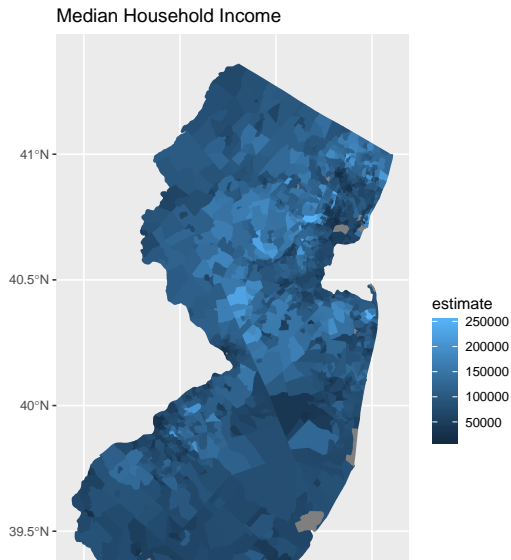
```
## $ geometry   <MULTIPOLYGON [°]> MULTIPOLYGON (((-74.46816
```

Plotting census data with ggplot2

- ▶ The `geometry = TRUE` argument in `get_acs()` downloads polygon information for plotting
- ▶ the `geom_sf()` function in `ggplot2` can use that information, but currently only the development version of the `ggplot2` package:

```
devtools::install_github("tidyverse/ggplot2")
```

```
nj_median_household_income2 %>%  
  ggplot(aes(fill = estimate, color = estimate)) +  
  geom_sf() +  
  ggtitle("Median Household Income")
```



```
middlesex_rental <-  
  get_acs(  
    geography = "tract",  
    variables = c(medrental = "B25064_001"),  
    state = "NJ",  
    county = "Middlesex",  
    geometry = TRUE  
  )
```

Getting data from the 2014-2018 5-year ACS

Downloading feature geometry from the Census website. 7

```
glimpse(middlesex_rental)
```

```
## Observations: 175
```

```
## Variables: 6
```

```
## $ GEOID      <chr> "34023000100", "34023000200", "34023000300",
```

```
## $ NAME       <chr> "Census Tract 1, Middlesex County, New
```

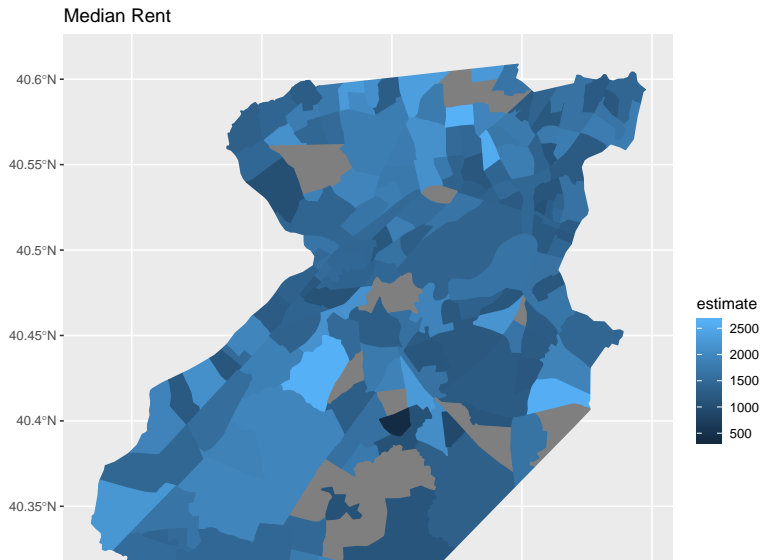
```
## $ variable   <chr> "medrental", "medrental", "medrental",
```

```
## $ estimate   <dbl> 1321, 1414, 1267, 1792, 2111, 1434, 1731,
```

```
## $ moe        <dbl> 118, 165, 219, 502, 107, 60, 452, 75, 100,
```

```
## $ geometry   <MULTIPOLYGON [°]> MULTIPOLYGON (((-74.52667
```

```
middlesex_rental %>%  
  ggplot(aes(fill = estimate, color = estimate)) +  
  geom_sf() +  
  ggtitle("Median Rent")
```



Leaflet

- ▶ Leaflet is a very popular set of Javascript libraries for interactive maps.
- ▶ There is a nice R package `leaflet`, to interface with them.
- ▶ There are lots of details at <https://rstudio.github.io/leaflet/>

To quote that webpage, the basic usage is

1. Create a map widget by calling `leaflet()`.
2. Add layers (i.e., features) to the map by using layer functions (e.g. `addTiles`, `addMarkers`, `addPolygons`) to modify the map widget.
3. Repeat step 2 as desired.
4. Print the map widget to display it.

```
pal <- colorQuantile("Greens", domain = nj_median_household_income2)

nj_median_household_income2 %>%
  st_transform(crs = "+init=epsg:4326") %>%
  leaflet() %>%
  addProviderTiles(provider = "CartoDB.Positron") %>%
  addPolygons(popup = ~ str_extract(NAME, "^([^\,]*)"),
    stroke = FALSE,
    smoothFactor = 0,
    fillOpacity = 0.5,
    color = ~ pal(estimate)) %>%
  addLegend("bottomright",
    pal = pal,
    values = ~ estimate,
    title = "Median Household Income",
    opacity = 1)
```

In class assignment

- ▶ Generate a leaflet interactive map of rent (at the census tract level) in NJ.