USA Census shapefile tests (in R)

The object here is to see if we can download and use census shapefiles.

- First, let's install the tigris libraries and load them up. Then have commented out code to do a quick plot of the states to see if things are working as they should be. Look up the codes for a county next.
- Then we'll learn how to extract some census tracts and plot these, along with the test location
- Finally, we will run a couple of tests to see if we can correctly identify whether the test location is inside the test regions.

In [14]:

```
#devtools::install_github('walkerke/tigris')
library(tigris)
library(magrittr)
#states() %>% plot()
lookup_code("Colorado", "Boulder County")
```

Out[14]:

"The code for Colorado is '08' and the code for Boulder County is '013'."

Now that we have the appropriate state and county codes, we can fetch the data by supplying the state FIPS code for Colorado and an appropriate vector of county codes. We also can supply the argument (was formerly called "detailed") cb = FALSE to return a simplified (and faster to download) dataset which is suitable for mapping.

Census Tracts are small, relatively permanent statistical subdivisions of a county or equivalent entity that are updated by local participants prior to each decennial census as part of the Census Bureau’s Participant Statistical Areas Program. The Census Bureau delineates census tracts in situations where no local participant existed or where state, local, or tribal governments declined to participate. The primary purpose of census tracts is to provide a stable set of geographic units for the presentation of statistical data.

Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. A census tract usually covers a contiguous area; however, the spatial size of census tracts varies widely depending on the density of settlement.Census tract boundaries are delineated with the intention of being maintained over a long time so that statistical comparisons can be made from census to census. Census tracts occasionally are split due to population growth or merged as a result of substantial population decline.

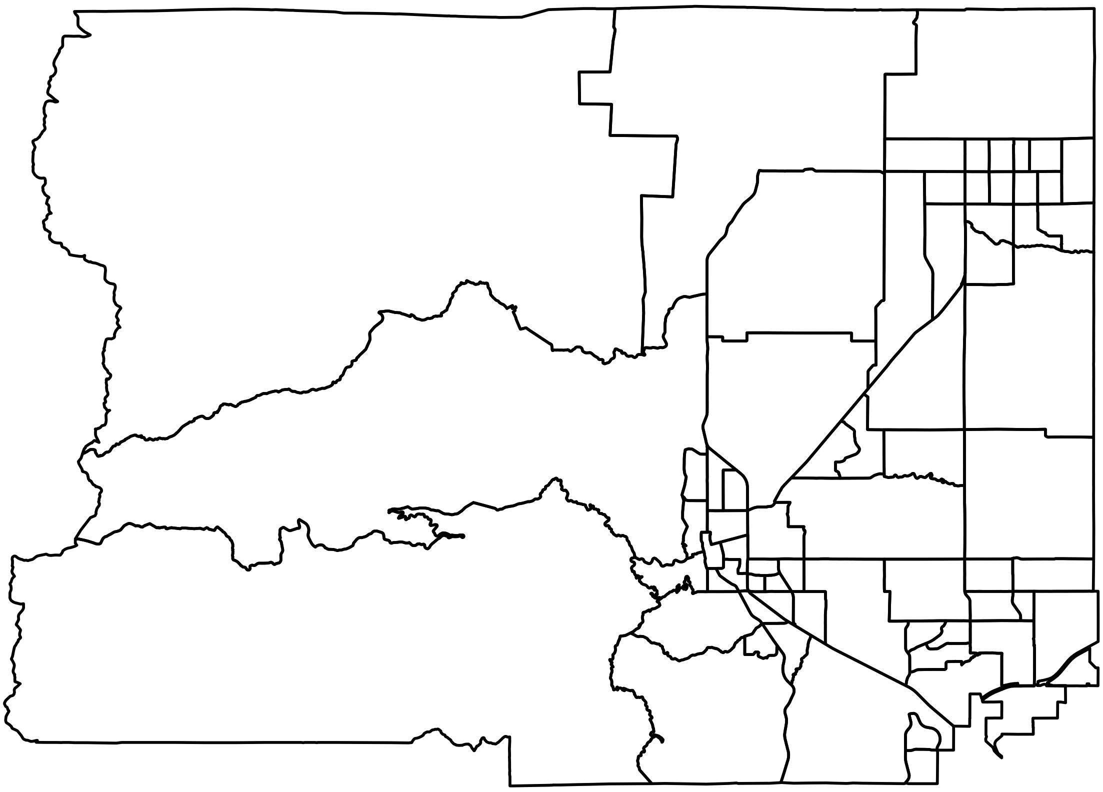
Census tract boundaries generally follow visible and identifiable features. They may follow nonvisible legal boundaries, such as minor civil division (MCD) or incorporated place boundaries in some states and situations, to allow for census-tract-to-governmental-unit relationships where the governmental boundaries tend to remain unchanged between censuses. State and county boundaries always are census tract boundaries in the standard census geographic hierarchy.

In [15]:

```
dfw <- tracts(state = '08', county = c('013'), cb = FALSE)
```

In [16]:

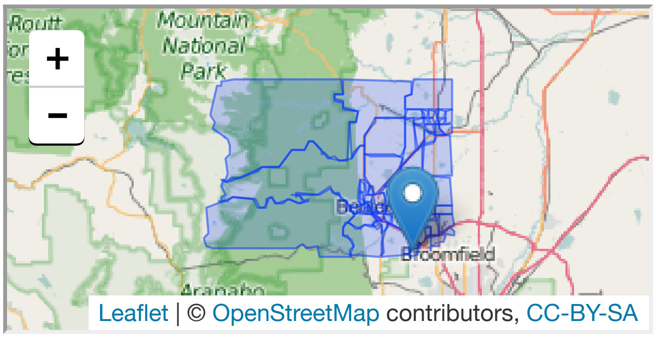
```
plot(dfw)
```



Tried to install extra software from [https://github.com/ellisonbg/ipyleaflet (https://github.com/ellisonbg/ipyleaflet)](https://github.com/ellisonbg/ipyleaflet) to run leaflet in Jupyter, but it was not needed. The following works OK.

In [17]:

```
library(leaflet)
require(maptools)
test_latitude <- 39.9205775
test_longitude <- -105.1634785
m <- leaflet(dfw) %>%
  addTiles() %>%  # Add default OpenStreetMap map tiles
  addMarkers(lng=test_longitude, lat=test_latitude, popup="Test Location") %>%
  addPolygons(weight = 1)
tf = 'myfigure.html'
htmlwidgets::saveWidget(m, file = tf, selfcontained = F)
IRdisplay::display_html(paste("<iframe src=' ", tf, " ' ","/>"))
```



In [18]:

```
head(fips_codes)
str(fips_codes)
```

Out[18]:

	state	state_code	state_name	county_code	county
1	AL	01	Alabama	001	Autauga County
2	AL	01	Alabama	003	Baldwin County
3	AL	01	Alabama	005	Barbour County
4	AL	01	Alabama	007	Bibb County
5	AL	01	Alabama	009	Blount County
6	AL	01	Alabama	011	Bullock County

```
'data.frame':   3235 obs. of  5 variables:
 $ state      : chr  "AL" "AL" "AL" "AL" ...
 $ state_code : chr  "01" "01" "01" "01" ...
 $ state_name : chr  "Alabama" "Alabama" "Alabama" "Alabama" ...
 $ county_code: chr  "001" "003" "005" "007" ...
 $ county     : chr  "Autauga County" "Baldwin County" "Barbour C
ounty" "Bibb County" ...
```

In [19]:

```
head(dfw)
```

```
Slot "data":
   STATEFP COUNTYFP TRACTCE       GEOID   NAME            NAMELSA
D MTFCC
70      08      013  013503 08013013503 135.03 Census Tract 135.0
3 G5020
76      08      013  012102 08013012102 121.02 Census Tract 121.0
2 G5020
77      08      013  012104 08013012104 121.04 Census Tract 121.0
4 G5020
78      08      013  012105 08013012105 121.05 Census Tract 121.0
5 G5020
79      08      013  012101 08013012101 121.01 Census Tract 121.0
1 G5020
81      08      013  012202 08013012202 122.02 Census Tract 122.0
2 G5020
   FUNCSTAT   ALAND AWATER    INTPTLAT     INTPTLON
70        S 1950396      0 +40.1812420 -105.0953408
76        S 2882031      0 +40.0299035 -105.2706095
77        S 2700872  96592 +40.0507733 -105.2869740
78        S 2475518    470 +40.0502082 -105.2772891
79        S 2860008      0 +40.0296853 -105.2895546
```

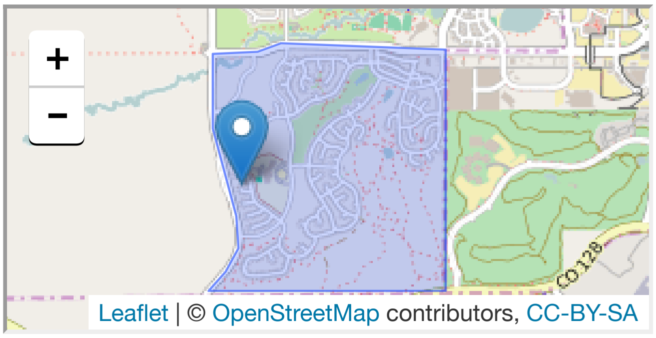
In [20]:

```
#080130614001017
test_region <- dfw[dfw@data$GEOID == '08013061400',]
str(test_region)
```

```
Formal class 'SpatialPolygonsDataFrame' [package "sp"] with 5 slo
ts
  ..@ data       :'data.frame': 1 obs. of  12 variables:
  .. ..$ STATEFP : chr "08"
  .. ..$ COUNTYFP: chr "013"
  .. ..$ TRACTCE : chr "061400"
  .. ..$ GEOID   : chr "08013061400"
  .. ..$ NAME    : chr "614"
  .. ..$ NAMELSAD: chr "Census Tract 614"
  .. ..$ MTFCC   : chr "G5020"
  .. ..$ FUNCSTAT: chr "S"
  .. ..$ ALAND   : num 2579580
  .. ..$ AWATER  : num 8890
  .. ..$ INTPTLAT: chr "+39.9209698"
  .. ..$ INTPTLON: chr "-105.1567997"
  ..@ polygons   :List of 1
  .. ..$ :Formal class 'Polygons' [package "sp"] with 5 slots
  .. .. .. ..@ Polygons :List of 1
  .. .. .. .. ..$ :Formal class 'Polygon' [package "sp"] with 5 s
lots
  .. .. .. .. .. .. ..@ labpt  : num [1:2] -105.2 39.9
  .. .. .. .. .. .. ..@ area   : num 0.000273
  .. .. .. .. .. .. ..@ hole   : logi FALSE
  .. .. .. .. .. .. ..@ ringDir: int 1
  .. .. .. .. .. .. ..@ coords : num [1:114, 1:2] -105 -105 -105
-105 -105 ...
  .. .. .. ..@ plotOrder: int 1
  .. .. .. ..@ labpt    : num [1:2] -105.2 39.9
  .. .. .. ..@ ID       : chr "1124"
  .. .. .. ..@ area     : num 0.000273
  ..@ plotOrder  : int 1
  ..@ bbox       : num [1:2, 1:2] -105.2 39.9 -105.1 39.9
  .. ..- attr(*, "dimnames")=List of 2
  .. .. ..$ : chr [1:2] "x" "y"
  .. .. ..$ : chr [1:2] "min" "max"
  ..@ proj4string:Formal class 'CRS' [package "sp"] with 1 slot
  .. .. ..@ projargs: chr "+proj=longlat +datum=NAD83 +no_defs +e
llps=GRS80 +towgs84=0,0,0"
```

In [21]:

```
m <- leaflet(test_region) %>%
  addTiles() %>%  # Add default OpenStreetMap map tiles
  addMarkers(lng=test_longitude, lat=test_latitude, popup="Test Location") %>%
  addPolygons(weight=1)
tf = 'myfigure.html'
htmlwidgets::saveWidget(m, file = tf, selfcontained = F)
IRdisplay::display_html(paste("<iframe src=' ", tf, " ' ","/>"))
```



Test to see if the test location is inside the selected region

Valid case

If it is, then we will see TRUE printed below

In [22]:

```
library(rgeos)
library(sp)
library(rgdal)
```

In [23]:

```
point <- data.frame(lon=test_longitude, lat=test_latitude)
sp2   <- SpatialPoints(point,proj4string=CRS(proj4string(test_region)))
gContains(test_region,sp2)
```

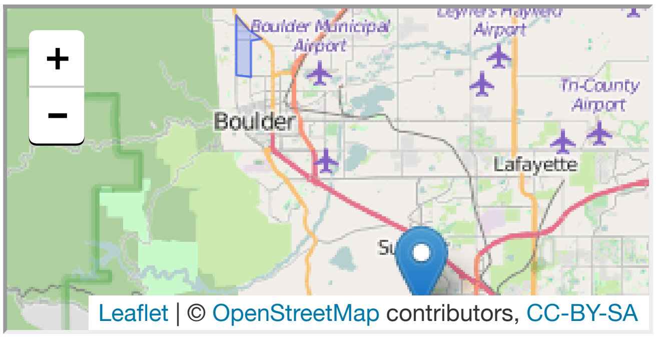
Out[23]:

```
TRUE
```

Invalid case

In [24]:

```
test_region <- dfw[dfw@data$GEOID == '08013012105',]
m <- leaflet(test_region) %>%
  addTiles() %>%  # Add default OpenStreetMap map tiles
  addMarkers(lng=test_longitude, lat=test_latitude, popup="Test Location") %>%
  addPolygons(weight=1)
tf = 'myfigure.html'
htmlwidgets::saveWidget(m, file = tf, selfcontained = F)
IRdisplay::display_html(paste("<iframe src=' ", tf, " ' ","/>"))
point <- data.frame(lon=test_longitude, lat=test_latitude)
sp2   <- SpatialPoints(point,proj4string=CRS(proj4string(test_region)))
gContains(test_region,sp2)
```


+
−
Boulder Municipal Airport
Leyners Hayward Airport
Tri-County Airport
Boulder
Lafayette
Su
Leaflet | © OpenStreetMap contributors, CC-BY-SA

Out[24]:

```
FALSE
```

OK, we are able to test correctly if a region falls within a given shapefile.

Additional Tests with the Tigris Library

In [25]:

```
#places("Maine")
list_counties("Colorado")
```

Out[25]:

	county	county_code
1	Adams	001
2	Alamosa	003
3	Arapahoe	005
4	Archuleta	007
5	Baca	009
6	Bent	011
7	Boulder	013
8	Broomfield	014
9	Chaffee	015
10	Cheyenne	017
11	Clear Creek	019
12	Conejos	021
13	Costilla	023
14	Crowley	025
15	Custer	027
16	Delta	029
17	Denver	031
18	Dolores	033
19	Douglas	035
20	Eagle	037
21	Elbert	039
22	El Paso	041
23	Fremont	043
24	Garfield	045
25	Gilpin	047
26	Grand	049
27	Gunnison	051
28	Hinsdale	053

29	Huerfano	055
30	Jackson	057
⋮	⋮	⋮
35	La Plata	067
36	Larimer	069
37	Las Animas	071
38	Lincoln	073
39	Logan	075
40	Mesa	077
41	Mineral	079
42	Moffat	081
43	Montezuma	083
44	Montrose	085
45	Morgan	087
46	Otero	089
47	Ouray	091
48	Park	093
49	Phillips	095
50	Pitkin	097
51	Prowers	099
52	Pueblo	101
53	Rio Blanco	103
54	Rio Grande	105
55	Routt	107
56	Saguache	109
57	San Juan	111
58	San Miguel	113
59	Sedgwick	115
60	Summit	117
61	Teller	119
62	Washington	121
63	Weld	123
64	Yuma	125

In [26]:

```
print(dfw$GEOID)
```

```
 [1] "08013013503" "08013012102" "08013012104" "08013012105" "080
13012101"
 [6] "08013012202" "08013012204" "08013012300" "08013012203" "080
13012505"
[11] "08013012507" "08013012501" "08013012701" "08013012603" "080
13012511"
[16] "08013012509" "08013012508" "08013012903" "08013012705" "080
13012708"
[21] "08013012709" "08013012905" "08013012907" "08013012904" "080
13013003"
[26] "08013060900" "08013013004" "08013013207" "08013013005" "080
13013205"
[31] "08013013006" "08013013202" "08013012510" "08013012401" "080
13013305"
[36] "08013013307" "08013013302" "08013013210" "08013013211" "080
13013308"
[41] "08013013208" "08013013401" "08013013402" "08013013701" "080
13012103"
[46] "08013013702" "08013012710" "08013012707" "08013012201" "080
13013201"
[51] "08013013601" "08013012800" "08013060700" "08013013602" "080
13013306"
[56] "08013012605" "08013060600" "08013013213" "08013060800" "080
13012607"
[61] "08013013505" "08013012608" "08013013506" "08013061400" "080
13013508"
[66] "08013013507" "08013061300" "08013013212"
```

In [ ]: