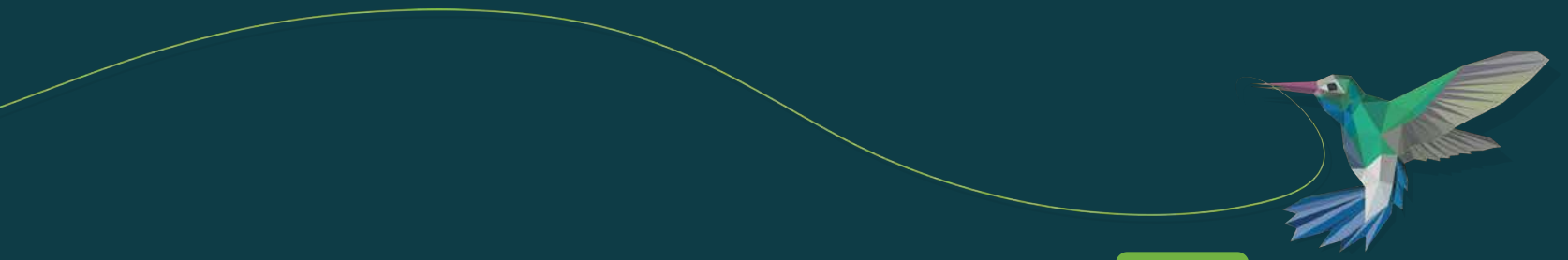
Getting Geospatial Data Into R



ZevRoss
Know Your Data

Ways to get spatial data into R

- Load external spatial files
- Load or fetch data with specialized R packages

In this section I'll be showing some code I'll cover in more detail later

Reading in existing data

What function you use depends on the type of data

- Read **vector** data with the {sf} package
- Read **raster** data with the {raster} package

Reading vector data

For vector data use `read_sf()` from {sf}

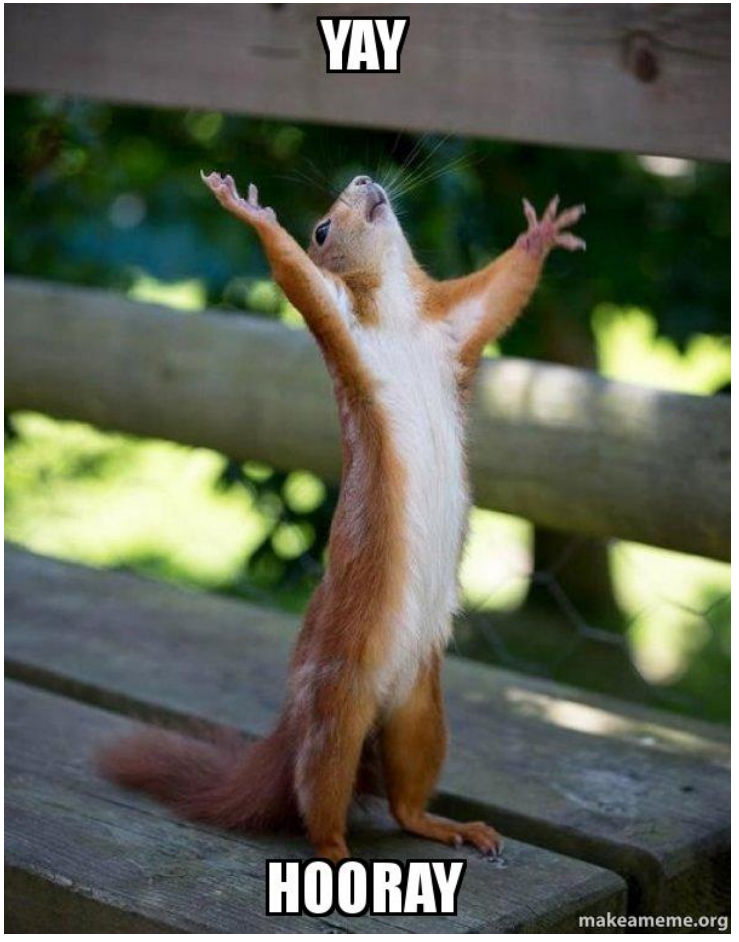
You can also use `st_read()` from {sf} but `read_sf()` is more "tidy"

- `stringsAsFactors = FALSE`
- `quiet = TRUE`
- `as_tibble = TRUE`

`read_sf()` to read many different file types

- Shapefiles
- Geopackages
- Geojson
- Even databases!

This makes things so much easier!



A little more detail on the most common vector file types

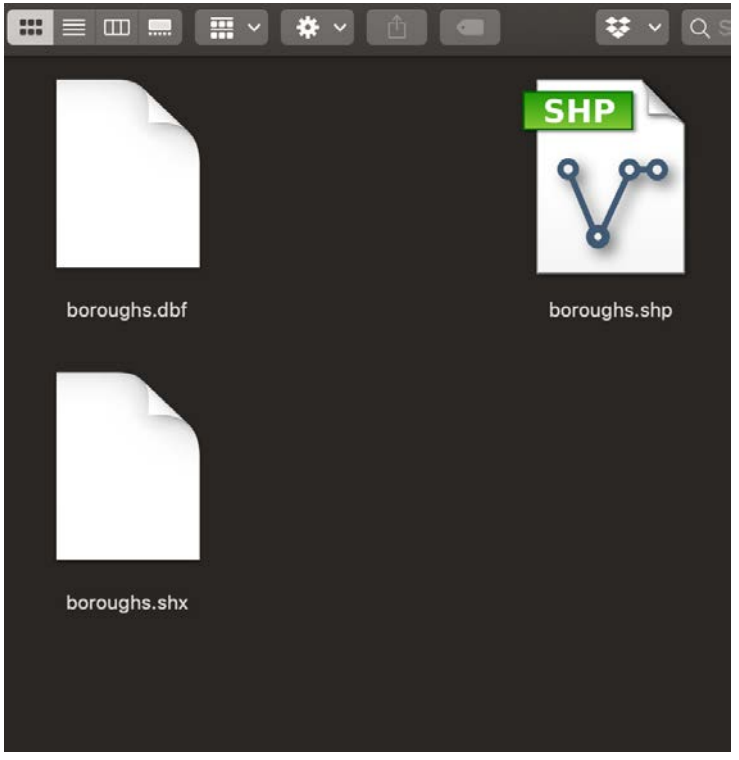
Shapefiles are the most common spatial files

Shapefiles have been around a long time!

Shapefiles can be unpleasant to work with

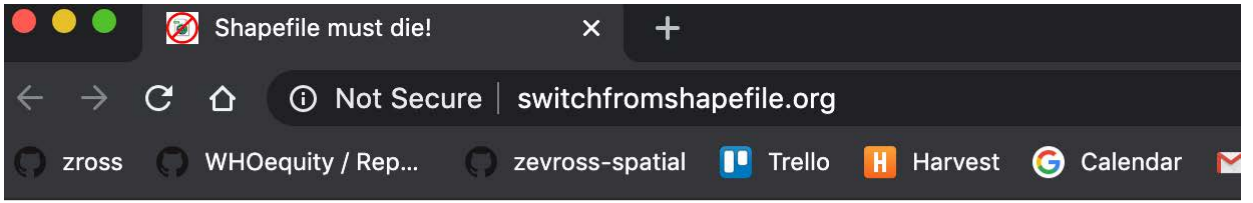
- Columns can only be 10 or fewer characters
- Inconveniently a single shapefile is represented by multiple files

This is one "shapefile"



A shapefile can also have several other associated files

Time to move away from shapefiles



Switch from Shapefile

ESRI Shapefile is a file format for storing geospatial vector data. I
and is still the most commonly used vector data exchange forma

While Shapefiles have enabled many successful activities over the years, th
complicate software development and reduce efficiency.

We, members of the geospatial IT industry, believe that it is time to stop usi
format and to replace them with a format that takes advantage of the huge
was introduced.

Read more:

- The good side
- Shapefile is a bad format
- Shapefile alternatives

Geopackages are rapidly gaining acceptance

- Open format
- Just one file, technically they are a SQLite container
- Can store multiple layers in one file

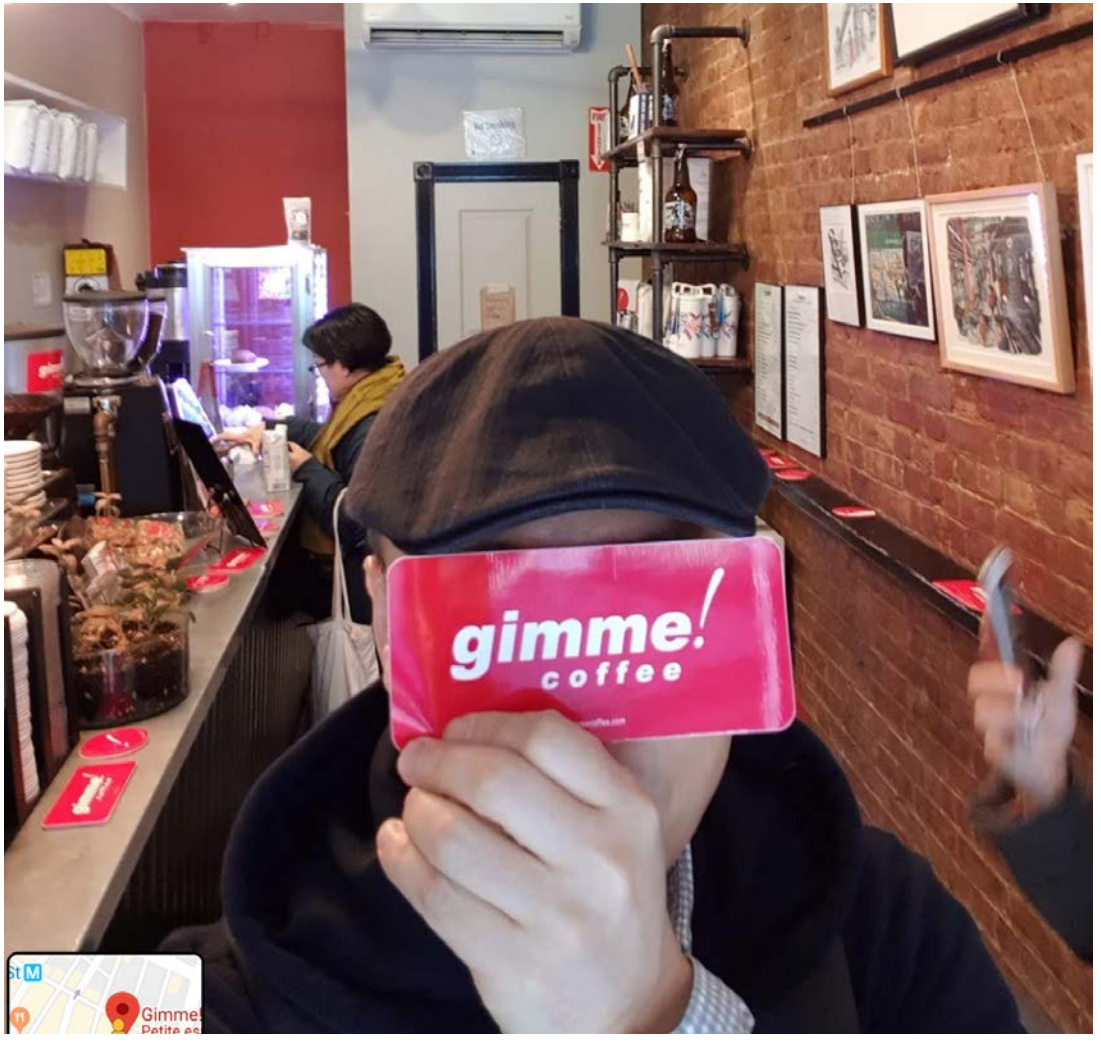
Geojson, spatial data for the web

- geojson is json (javascript) with geographic attributes
- Files can be a little larger
- Extension is usually `.geojson` (sometimes `.json`)
- Can only be latitude/longitude

One point in geojson

```
{
  "type": "FeatureCollection",
  "crs": {
    "type": "name",
    "properties": {
      "name": "urn:ogc:def:crs:OGC:1.3:CRS84"
    }
  },
  "features": [{
      "type": "Feature",
      "properties": {
        "location": "Gimme! Coffee"
      },
      "geometry": {
        "type": "Point",
        "coordinates": [-73.995001, 40.722401]
      }
    }]
}
```

gimme! coffee, one of my favorites



A note on topojson, another format for the web

- Topojson is similar to geojson but stores geometries more efficiently
- For example, a border between two countries would be stored just once.
- `read_sf()` can also read this

Let's see `read_sf()` in action

Simple example of `read_sf()`

```
library(sf)
boroughs <- read_sf("boroughs.shp")
```

`read_sf()` has a consistent syntax

```
boroughs <- read_sf("boroughs.shp")
boroughs <- read_sf("boroughs.geojson")
boroughs <- read_sf("boroughs.gpkg")
```

The result will be a {sf} table ... more details later

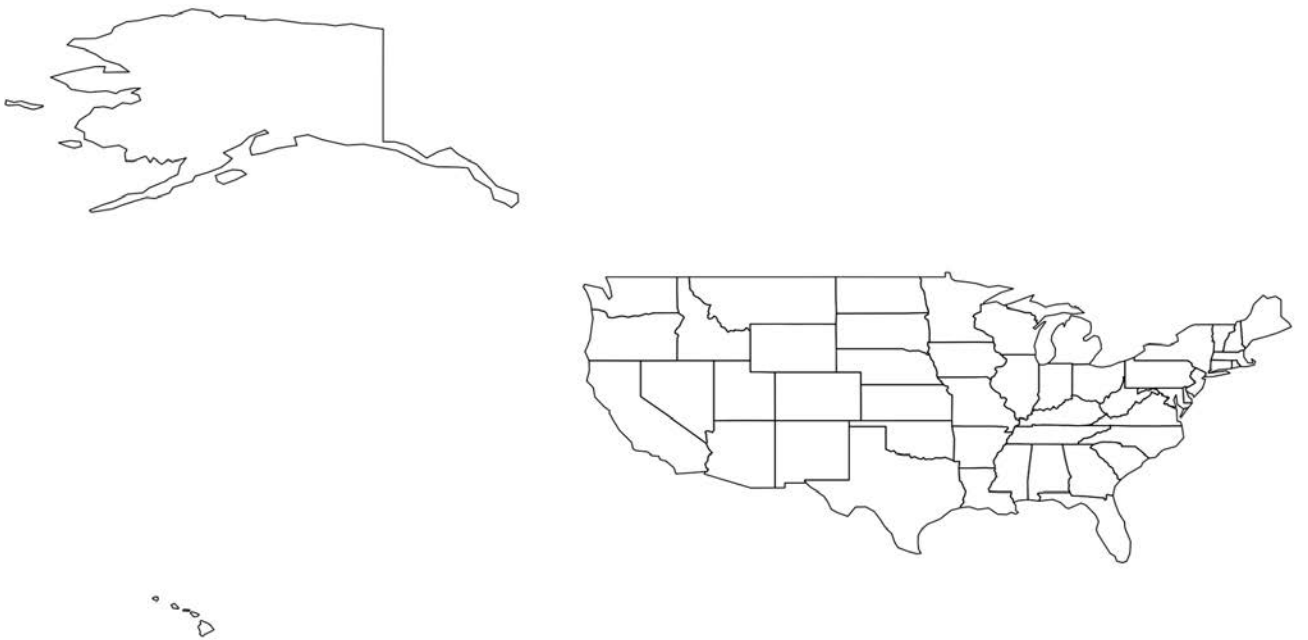
```
glimpse(boroughs)
```

```
## Observations: 5
## Variables: 7
## $ BoroCode   <int> 1, 2, 5, 3, 4
## $ BoroName   <chr> "Manhattan", "The Bronx", "Staten…
## $ Shape_Leng <dbl> 339736.6, 397460.6, 318700.5, 576…
## $ Shape_Area <dbl> 635147797, 1182399343, 1630762350…
## $ diso       <int> 1, 1, 1, 1, 1
## $ AreaSqMile <dbl> 22.78279, 42.41274, 58.49555, 71.…
## $ geom       <MULTIPOLYGON [US_survey_foot]> MULTIPO…
```

You can also read from a URL directly

```
# Topojson
usa <- read_sf("http://bit.ly/2NhznGt")
```

```
# Plotting discussed later
st_geometry(usa) %>% plot()
```



A note on making non-spatial data spatial

- Addresses
- Coordinates
- Place names

If you have addresses, you need to "geocode" to get coordinates

```
# Uses Google Maps
ggmap::geocode("Hilton San Francisco Union Square")
```

```
# Uses Open Street Map
tmaptools::geocode_OSM("Hilton San Francisco Union Square",
        as.sf = TRUE) %>%
  glimpse()
```

```
## Observations: 1
## Variables: 8
## $ query    <chr> "Hilton San Francisco Union Square"
## $ lat      <dbl> 37.78573
## $ lon      <dbl> -122.4104
## $ lat_min  <dbl> 37.78519
## $ lat_max  <dbl> 37.78612
## $ lon_min  <dbl> -122.4112
## $ lon_max  <dbl> -122.4096
## $ geometry <POINT [°]> POINT (-122.4104 37.78573)
```

What if you have coordinates?

You need to convert them to a spatial object with {sf}

Here is a table of coordinates

```
regular_table
```

```
## # A tibble: 2 x 4
##      id latitude longitude name
##   <int>    <dbl>     <dbl> <chr>
## 1     1     40.7     -74.0 Empire State Building
## 2     2     40.7     -74.0 One World Trade Center
```

By the way X = longitude and Y = latitude

A mnemonic for latitude, longitude…

"A lat lays flat"

"Lat are steps on a ladder"

We'll cover this in more detail later but...

You use `sf::st_as_sf()` to convert coordinates to an {sf} object

```
spatial_table <- regular_table %>%
  st_as_sf(coords = c("longitude", "latitude"), crs = 4326)
```

```
st_geometry(spatial_table) %>% plot(cex = 2, col = "blue")
```

How about place names?

You need to link them to a spatial boundary file

An example with US states

```
# My list of place names
my_states <- data.frame(NAME = c("California", "Nevada"))
my_states
```

```
##          NAME
## 1 California
## 2     Nevada
```

Find an R package or spatial file with the boundaries

More on this topic in a second

```
options(tigris_class = "sf")
states <- tigris::states()
```

Join your place names with the geographic file

```
states <- inner_join(states, my_states, by = c("NAME"))
```

```
# Plot! Code explained later
tm_shape(states) + tm_polygons() + tm_text("NAME", size = 2)
```

Write with `write_sf()`

```
write_sf(spatial_table, "spatial_table.shp")
write_sf(spatial_table, "spatial_table.gpkg")
write_sf(spatial_table, "spatial_table.geojson")
```

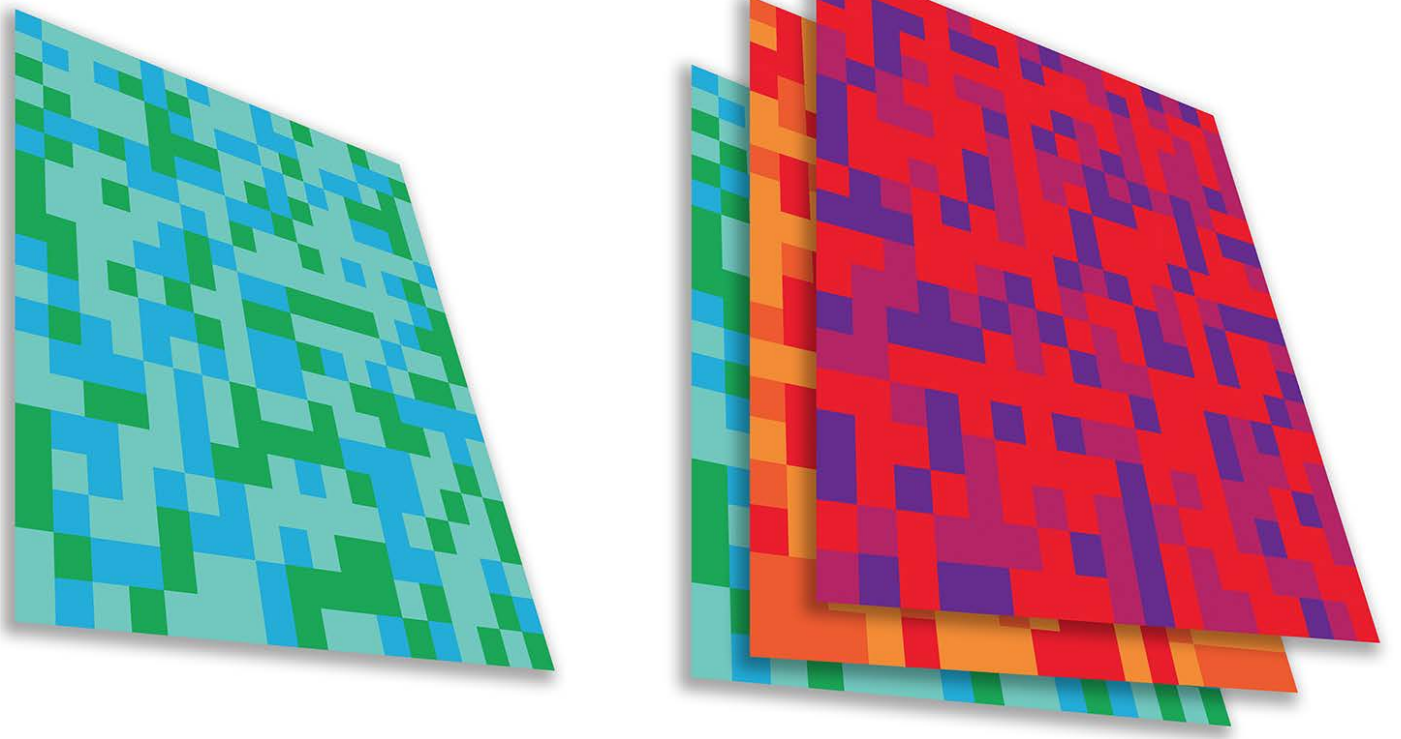
Reading raster data

For raster data use `raster()` and `brick()` from {raster}

Which to use depends on the raster

- Use `raster()` for single-band images (e.g. elevation)
- Use `brick()` for multi-band images (e.g. satellite data)

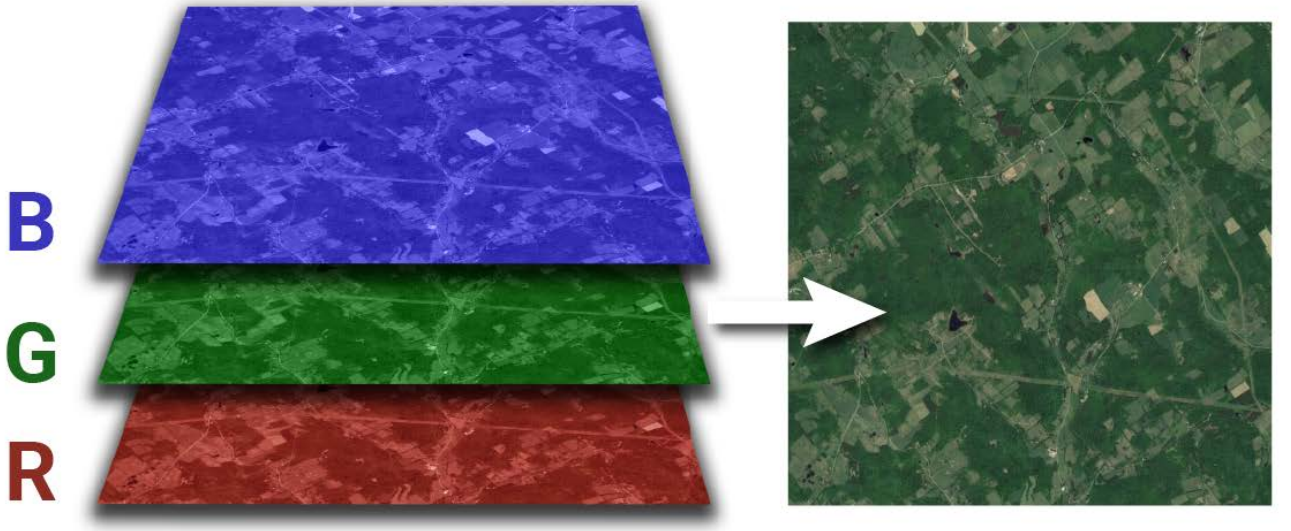
Single vs multi-band



Single Band Raster

Multi Band Raster

Common multi-band raster -- a color image



Note that there is also a `stack()` function

- A sort of "virtual" raster brick
- Can refer to more than one file on disk
- We will not cover this

`raster()` and `brick()` can read many different file types

- TIFF/GeoTIFF
- IMG
- HDF4/5

A little more detail on the most common raster file types

TIFF/GeoTIFF are the most common raster format

- TIFF images can come with an extra "world" file (.tfw)
- A TIFF with the world file embedded is a GeoTIFF
- For storing single or multi-band rasters

ERDAS Imagine file

- For storing single and multi-band rasters
- Suffix is .img

HDF4/5

- Hierarchical data format for large scientific data
- Multidimensional (often include both space and time and more than one image)

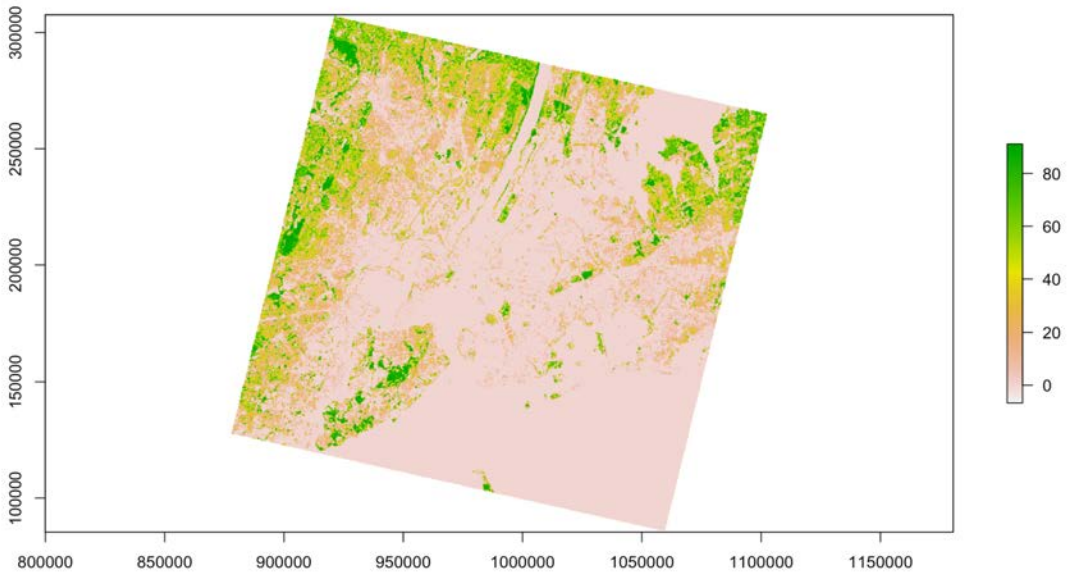
All of these formats can store single or multi-band images

`raster()` for single band

Or to read one band from a multi-band image

```
library(raster)
canopy <- raster("canopy.tif")
```

```
plot(canopy)
```



`brick()` for multi-band

```
manhattan <- brick("manhattan.tif")
```

```
plotRGB(manhattan)
```

Write with `writeRaster()` for both single and multi-layer files

```
writeRaster(canopy, "canopy.tif")
writeRaster(canopy, "canopy.grd")
```

R packages for getting spatial data

There are more than a dozen high quality packages for fetching data

Examples include...

- {rnaturalearth} - country and sub-country boundaries, coastline, roads etc
- {FedData} - mostly US-focused, elevation, landcover, climate
- {tidycensus} - US only, census data and geography

Quick examples of retrieving data using R packages

{rnaturalearth}

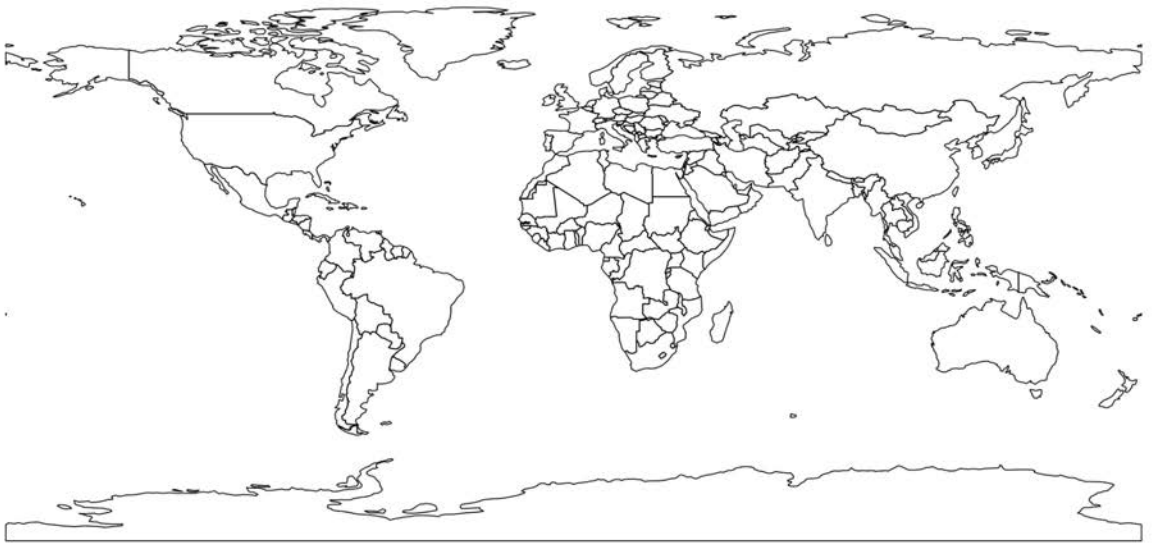
{rnaturalearth}

- Countries, states, airports, roads, urban areas, railroads, ocean and more
- Retrieves vector data
- Andy South, https://github.com/ropensci/rnaturalearth

{rnaturalearth} to get countries of the world

```
library(rnaturalearth)
countries <- ne_countries(returnclass = "sf")
```

```
# We will talk about st_geometry() in the next section
st_geometry(countries) %>% plot()
```



{FedData}

- Elevation, hydrography, soils, climate, land cover
- Retrieves raster data
- Kyle Bocinsky, https://github.com/ropensci/FedData

www.mrlc.gov

{FedData} elevation in two steps

Step 1, define your extent:

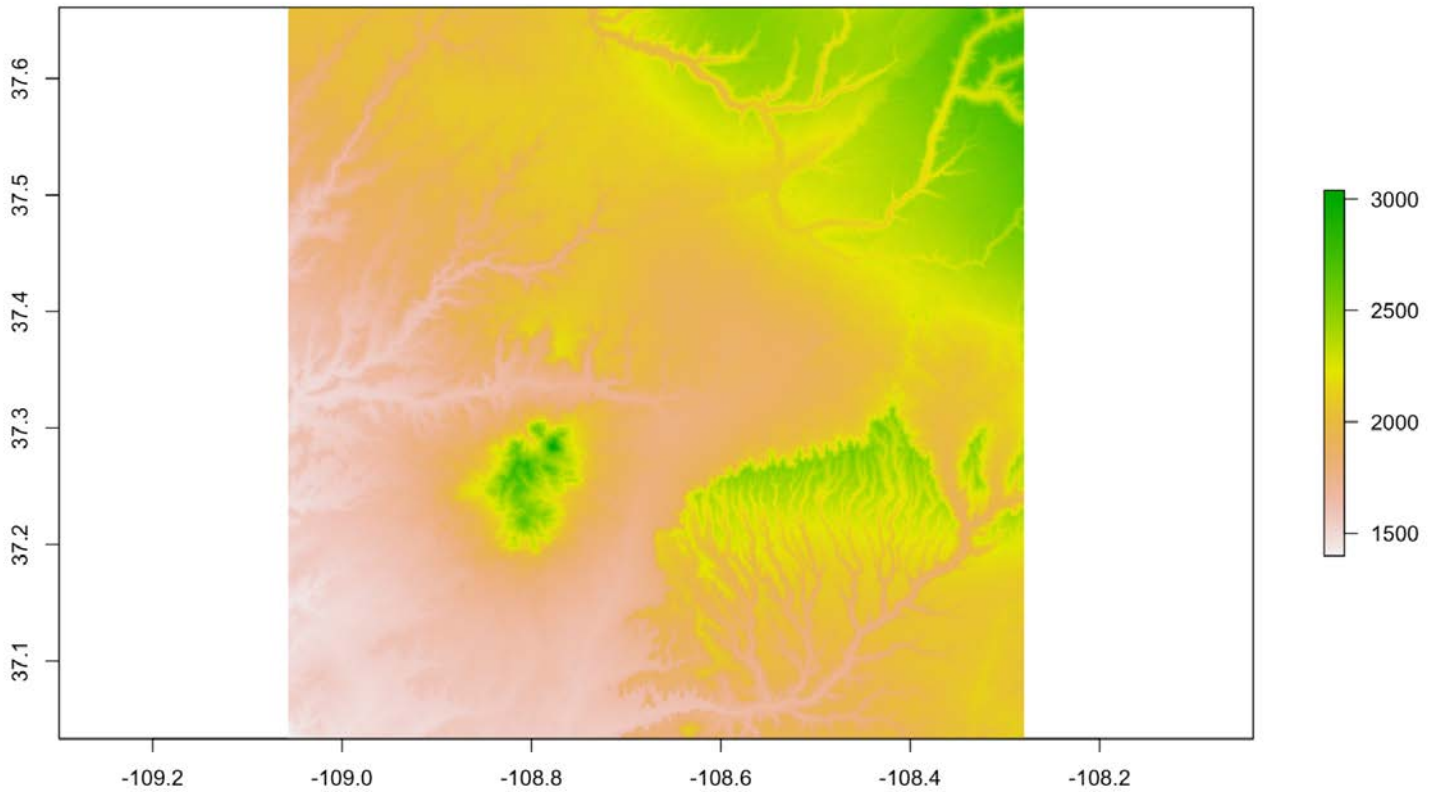
```
library(FedData)

poly <- polygon_from_extent(
  raster::extent(672800, 740000, 4102000, 4170000),
  proj4string = "+proj=utm +datum=NAD83 +zone=12")
```

Step 2, download elevation data

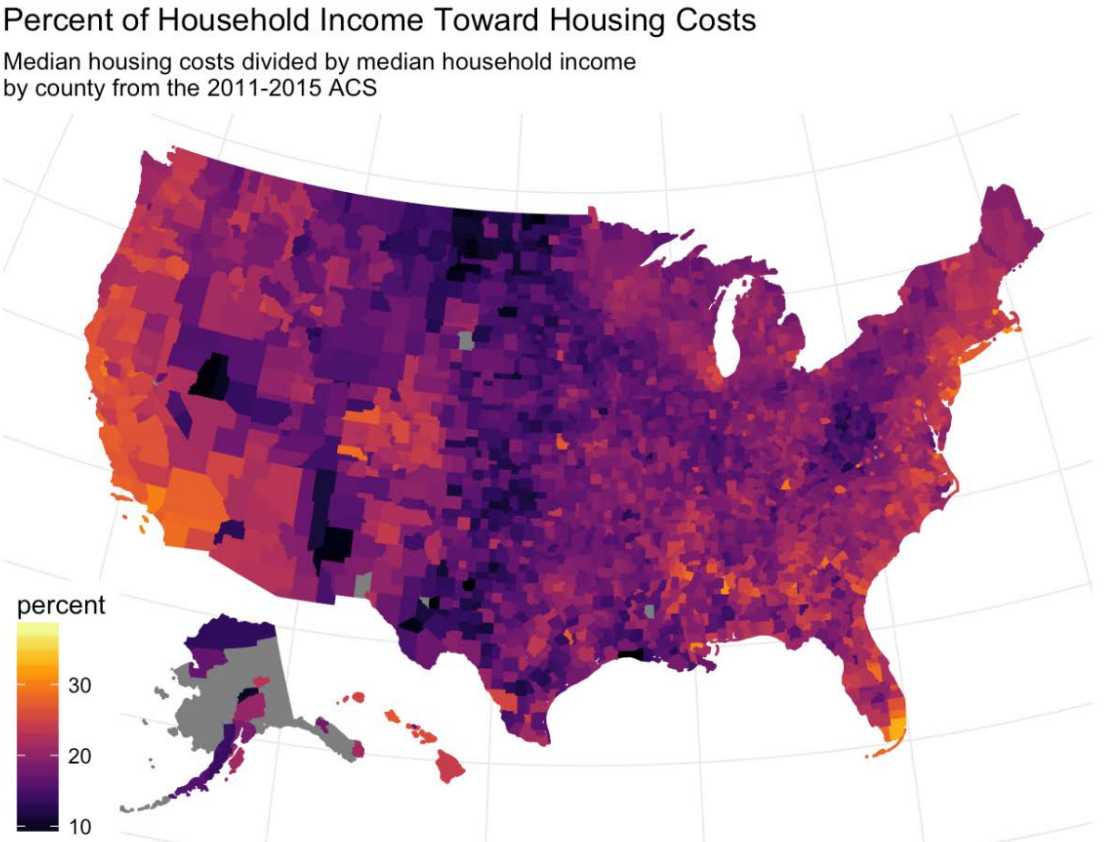
```
ned <- get_ned(template = poly, label = "elevation")
```

Plot the elevation data from {FedData}

```
raster::plot(ned)
```



{tidycensus}



Map by Austin Wehrwein

{tidycensus}

- Access US Census data and geography
- Super-handy for my work!
- Kyle Walker, https://github.com/walkerke/tidycensus

You need an API key from the Census!

- http://api.census.gov/data/key_signup.html
- census_api_key("YOUR KEY GOES HERE")

If all you need is census geography you can use {tigris} instead

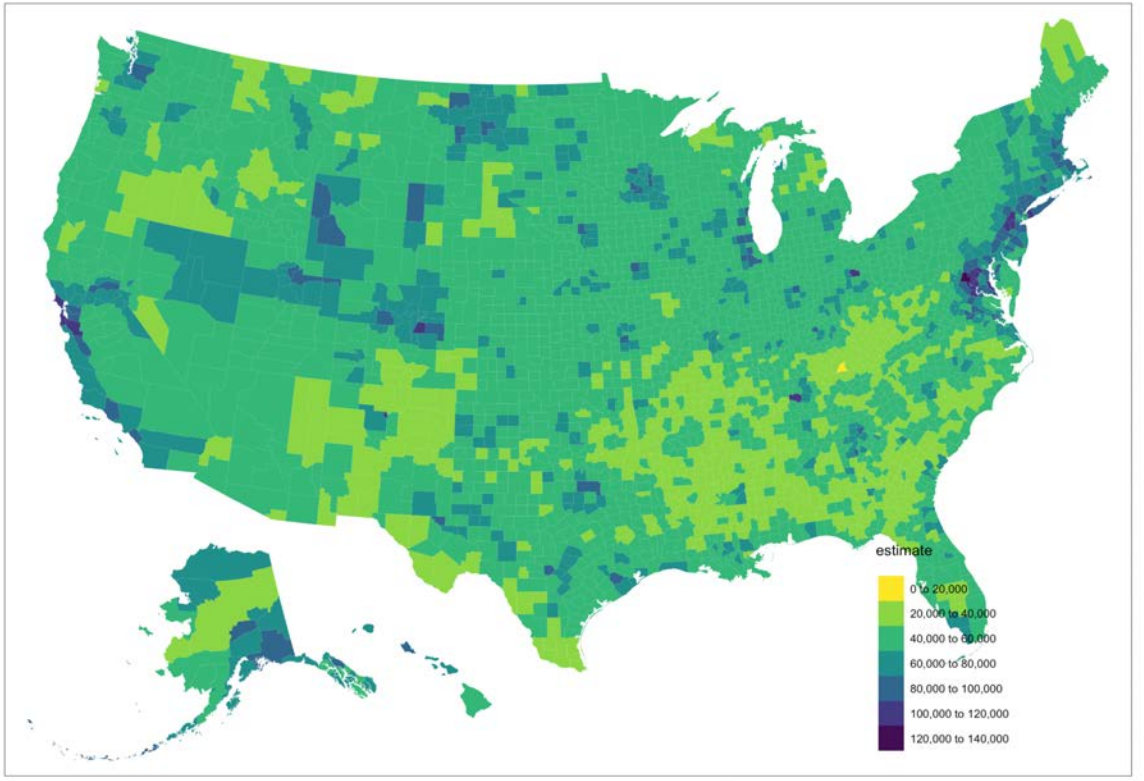
This is what `tidycensus` uses

Get the data median income

```
us_county_income <- get_acs(geography = "county",
                            variables = "B19013_001",
                            geometry = TRUE)
```

Plot the data

```
library(tmap)
tm_shape(us_county_income) +
  tm_fill("estimate", pal = "-viridis")
```



open_exercise(2)