

Data Visualization - 7.

Make Maps (2)

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Code Horizons

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Making Maps

Load our packages

```
library(here)      # manage file paths
library(socviz)    # data and some useful functions
library(tidyverse) # your friend and mine
library(maps)      # Some basic maps
library(sf)        # Simple Features Geometries and geom_sf()
library(ggforce)   # Useful enhancements to ggplot
```


Maps using Simple Features

`geom_polygon()` is limiting

It's very useful to have the intuition that, when drawing maps, we're just working with tables of `x` and `y` coordinates, and shapes represent quantities in our data, in a way that's essentially the same as any other geom. This makes it worth getting comfortable with what `geom_polygon()` and `coord_map()` are doing. But the business of having very large map tables and manually specifying projections is inefficient.

In addition, sometimes our data *really is* properly spatial, at which point we need a more rigorous and consistent way of specifying those elements. There's a whole world of Geodesic standards and methods devoted to specifying these things for GIS applications. R is not a dedicated GIS, but we can take advantage of these tools.

`geom_polygon()` is limiting

It's very useful to have the intuition that, when drawing maps, we're just working with tables of `x` and `y` coordinates, and shapes represent quantities in our data, in a way that's essentially the same as any other geom. This makes it worth getting comfortable with what `geom_polygon()` and `coord_map()` are doing. But the business of having very large map tables and manually specifying projections is inefficient.

In addition, sometimes our data *really is* properly spatial, at which point we need a more rigorous and consistent way of specifying those elements. There's a whole world of Geodesic standards and methods devoted to specifying these things for GIS applications. R is not a dedicated GIS, but we can take advantage of these tools.

Enter `simple features`, the `sf` package, and `geom_sf()`

The Simple Features package

When we load `sf` it creates a way to use several standard GIS concepts and tools, such as the `GEOS` library for computational geometry, the `PROJ` software that transforms spatial coordinates from one reference system to another, as in map projections, and the Simple Features standard for specifying the elements of spatial attributes.

```
library(sf)
```

```
Linking to GEOS 3.11.0, GDAL 3.5.3, PROJ 9.1.0; sf_use_s2() is TRUE
```

Let's see the main upshot for us.

The nycdogs package

```
library(nycdogs)
nyc_license

# A tibble: 493,072 × 9
  animal_name animal_gender animal_birth_year breed_rc      borough zip_code
  <chr>        <chr>           <dbl> <chr>          <chr>      <int>
1 Paige         F              2014 Pit Bull (or Mi... Manhat...  10035
2 Yogi          M              2010 Boxer            Bronx     10465
3 Ali            M              2014 Basenji          Manhat...  10013
4 Queen         F              2013 Akita Crossbreed Manhat...  10013
5 Lola           F              2009 Maltese          Manhat...  10028
6 Ian            M              2006 Unknown          Manhat...  10013
7 Buddy          M              2008 Unknown          Manhat...  10025
8 Chewbacca     F              2012 Labrador (or Cr... Manhat...  10013
9 Heidi-Bo      F              2007 Dachshund Smoot... Brookl... 11215
10 Massimo       M             2009 Bull Dog, French Brookl... 11201
# i 493,062 more rows
# i 3 more variables: license_issued_date <date>, license_expired_date <date>,
#   extract_year <dbl>
```



The **nycdogs** package

The metadata tells you this is not a regular tibble.

```
nyc_zips
```

```
Simple feature collection with 262 features and 11 fields
Geometry type: POLYGON
Dimension:     XY
Bounding box:  xmin: -74.25576 ymin: 40.49584 xmax: -73.6996 ymax: 40.91517
Geodetic CRS:  WGS 84
# A tibble: 262 × 12
  objectid zip_code po_name      state borough st_fips cty_fips bld_gpostal_code
    <int>    <int> <chr>        <chr>   <chr>   <chr>       <int>
1       1     11372 Jackson He...    NY    Queens     36      081           0
2       2     11004 Glen Oaks      NY    Queens     36      081           0
3       3     11040 New Hyde P...    NY    Queens     36      081           0
4       4     11426 Bellerose      NY    Queens     36      081           0
5       5     11365 Fresh Mead...    NY    Queens     36      081           0
6       6     11373 Elmhurst       NY    Queens     36      081           0
7       7     11001 Floral Park    NY    Queens     36      081           0
8       8     11375 Forest Hil...    NY    Queens     36      081           0
9       9     11427 Queens Vil...    NY    Queens     36      081           0
10      10    11374 Rego Park      NY    Queens     36      081           0
# i 252 more rows
```

The **nycdogs** package

```
nyc_zips ▷
```

```
  select(objectid:borough)
```

```
Simple feature collection with 262 features and 5 fields
Geometry type: POLYGON
Dimension: XY
Bounding box: xmin: -74.25576 ymin: 40.49584 xmax: -73.6996 ymax: 40.91517
Geodetic CRS: WGS 84
# A tibble: 262 × 6
  objectid zip_code po_name      state borough                         geometry
     <int>    <int>   <chr>     <chr>   <chr>                         <POLYGON [°]>
1       1     11372 Jackson Heights NY    Queens ((-73.86942 40.74916, -73.89...
2       2     11004 Glen Oaks        NY    Queens ((-73.71068 40.75004, -73.70...
3       3     11040 New Hyde Park    NY    Queens ((-73.70098 40.7389, -73.703...
4       4     11426 Bellerose        NY    Queens ((-73.7227 40.75373, -73.722...
5       5     11365 Fresh Meadows    NY    Queens ((-73.81089 40.72717, -73.81...
6       6     11373 Elmhurst         NY    Queens ((-73.88722 40.72753, -73.88...
7       7     11001 Floral Park      NY    Queens ((-73.70098 40.7389, -73.699...
8       8     11375 Forest Hills     NY    Queens ((-73.85625 40.73672, -73.85...
9       9     11427 Queens Village    NY    Queens ((-73.74169 40.73682, -73.73...
10      10    11374 Rego Park        NY    Queens ((-73.86451 40.73407, -73.85...
# i 252 more rows
```

The **polygon** column is a list of lat/lon points that, when joined, draw the outline of the zip code area. This is *much* more compact than a big table where every row is a single point.

Let's make a summary table

```
nyc_license
```

```
# A tibble: 493,072 × 9
  animal_name animal_gender animal_birth_year
  <chr>       <chr>           <dbl>
  breed_rc      borough        zip_code
  <chr>          <chr>           <int>
  1 Paige        F               2014
  Pit Bull (or Mi... Manhat...     10035
  2 Yogi         M               2010
  Boxer          Bronx          10465
  3 Ali           M               2014
  Basenji        Manhat...      10013
  4 Queen        F               2013
  Akita Crossbreed Manhat...      10013
  5 Lola          F               2009
  Maltese        Manhat...      10028
  6 Ian           M               2006
  Unknown        Manhat...      10013
  7 Buddy         M               2008
  Unknown        Manhat...      10025
```

Let's make a summary table

```
nyc_license %>  
  filter(extract_year == 2018)
```

```
# A tibble: 117,371 x 9  
  animal_name animal_gender animal_birth_year  
  breed_rc      borough zip_code  
  <chr>        <chr>       <dbl>  
  <chr>          <chr>       <int>  
  1 Ali           M            2014  
  Basenji        Manhat...    10013  
  2 Ian           M            2006  
  Unknown        Manhat...    10013  
  3 Chewbacca     F            2012  
  Labrador (or Cr... Manhat...    10013  
  4 Lola          F            2006  
  Miniature Pinsc... Manhat...    10022  
  5 Lucy          F            2014  
  Dachshund Smoot... Brookl...    11215  
  6 June          F            2010  
  Cavalier King C... Brookl...    11238  
  7 Apple          M            2013  
  Havanese        Manhat...    10025
```

Let's make a summary table

```
nyc_license %>  
  filter(extract_year == 2018) %>  
  group_by(breed_rc, zip_code)
```

```
# A tibble: 117,371 × 9  
# Groups:   breed_rc, zip_code [18,945]  
  animal_name animal_gender animal_birth_year  
  breed_rc      borough zip_code  
  <chr>        <chr>          <dbl>  
  <chr>        <chr>          <int>  
  1 Ali          M              2014  
  Basenji       Manhat...      10013  
  2 Ian          M              2006  
  Unknown       Manhat...      10013  
  3 Chewbacca    F              2012  
  Labrador (or Cr... Manhat...  10013  
  4 Lola          F              2006  
  Miniature Pinsc... Manhat...  10022  
  5 Lucy          F              2014  
  Dachshund Smoot... Brookl...  11215  
  6 June          F              2010  
  Cavalier King C... Brookl...  11238  
  7 Apple         M              2013
```

Let's make a summary table

```
nyc_license %>  
  filter(extract_year == 2018) %>  
  group_by(breed_rc, zip_code) %>  
  tally()
```

```
# A tibble: 18,945 × 3  
# Groups:   breed_rc [311]  
  breed_rc      zip_code     n  
  <chr>        <int> <int>  
1 Affenpinscher 10005     1  
2 Affenpinscher 10011     1  
3 Affenpinscher 10013     1  
4 Affenpinscher 10014     1  
5 Affenpinscher 10016     1  
6 Affenpinscher 10017     1  
7 Affenpinscher 10018     1  
8 Affenpinscher 10019     1  
9 Affenpinscher 10021     1  
10 Affenpinscher 10023    1  
# i 18,935 more rows
```

Let's make a summary table

```
nyc_license %>  
  filter(extract_year == 2018) %>  
  group_by(breed_rc, zip_code) %>  
  tally() %>  
  mutate(freq = n / sum(n))
```

```
# A tibble: 18,945 x 4  
# Groups:   breed_rc [311]  
  breed_rc      zip_code     n    freq  
  <chr>        <int> <int>  <dbl>  
1 Affenpinscher 10005     1  0.0303  
2 Affenpinscher 10011     1  0.0303  
3 Affenpinscher 10013     1  0.0303  
4 Affenpinscher 10014     1  0.0303  
5 Affenpinscher 10016     1  0.0303  
6 Affenpinscher 10017     1  0.0303  
7 Affenpinscher 10018     1  0.0303  
8 Affenpinscher 10019     1  0.0303  
9 Affenpinscher 10021     1  0.0303  
10 Affenpinscher 10023    1  0.0303  
# i 18,935 more rows
```

Let's make a summary table

```
nyc_license %>  
  filter(extract_year == 2018) %>  
  group_by(breed_rc, zip_code) %>  
  tally() %>  
  mutate(freq = n / sum(n)) %>  
  filter(breed_rc == "French Bulldog")
```

```
# A tibble: 161 × 4  
# Groups:   breed_rc [1]  
  breed_rc      zip_code     n    freq  
  <chr>        <int> <int>  <dbl>  
1 French Bulldog 10001     27 0.0167  
2 French Bulldog 10002     20 0.0123  
3 French Bulldog 10003     36 0.0222  
4 French Bulldog 10004      9 0.00555  
5 French Bulldog 10005     15 0.00925  
6 French Bulldog 10006      8 0.00494  
7 French Bulldog 10007     17 0.0105  
8 French Bulldog 10009     51 0.0315  
9 French Bulldog 10010     31 0.0191  
10 French Bulldog 10011    88 0.0543  
# i 151 more rows
```

Let's make a summary table

```
nyc_license %>  
  filter(extract_year == 2018) %>  
  group_by(breed_rc, zip_code) %>  
  tally() %>  
  mutate(freq = n / sum(n)) %>  
  filter(breed_rc == "French Bulldog") %>  
  nyc_fb
```

Let's make a summary table

```
nyc_license %>  
  filter(extract_year == 2018) %>  
  group_by(breed_rc, zip_code) %>  
  tally() %>  
  mutate(freq = n / sum(n)) %>  
  filter(breed_rc == "French Bulldog") %>  
  nyc_fb
```

Now we have two tables again

```
nyc_zips ▷ select(objectid:st_fips)
```

```
Simple feature collection with 262 features and 6 fields
Geometry type: POLYGON
Dimension: XY
Bounding box: xmin: -74.25576 ymin: 40.49584 xmax: -73.6996 ymax: 40.91517
Geodetic CRS: WGS 84
# A tibble: 262 × 7
  objectid zip_code po_name     state borough st_fips           geometry
    <int>    <int> <chr>      <chr> <chr>    <chr>      <POLYGON [°]>
1       1    11372 Jackson He... NY    Queens   36    ((-73.86942 40.74916, -7...
2       2    11004 Glen Oaks  NY    Queens   36    ((-73.71068 40.75004, -7...
3       3    11040 New Hyde P... NY    Queens   36    ((-73.70098 40.7389, -73...
4       4    11426 Belleroose NY    Queens   36    ((-73.7227 40.75373, -73...
5       5    11365 Fresh Mead... NY    Queens   36    ((-73.81089 40.72717, -7...
6       6    11373 Elmhurst  NY    Queens   36    ((-73.88722 40.72753, -7...
7       7    11001 Floral Park NY    Queens   36    ((-73.70098 40.7389, -73...
8       8    11375 Forest Hil... NY    Queens   36    ((-73.85625 40.73672, -7...
9       9    11427 Queens Vil... NY    Queens   36    ((-73.74169 40.73682, -7...
10      10   11374 Rego Park  NY    Queens   36    ((-73.86451 40.73407, -7...
# i 252 more rows
```

```
nyc_fb ▷ select(breed_rc:n)
```

```
# A tibble: 161 × 3
# Groups: breed_rc [1]
  breed_rc    zip_code     n
  <chr>        <int> <int>
1 French Bulldog 10001  27
2 French Bulldog 10002  20
3 French Bulldog 10003  36
4 French Bulldog 10004   9
5 French Bulldog 10005  15
6 French Bulldog 10006   8
7 French Bulldog 10007  17
8 French Bulldog 10009  51
9 French Bulldog 10010  31
10 French Bulldog 10011  88
# i 151 more rows
```

Join them:

```
fb_map ← left_join(nyc_zips, nyc_fb, by = "zip_code")
```

Ready to map

```
fb_map ▷ select(zip_code, po_name, borough, breed_rc:freq, geometry)
```

```
Simple feature collection with 262 features and 6 fields
Geometry type: POLYGON
Dimension:     XY
Bounding box:  xmin: -74.25576 ymin: 40.49584 xmax: -73.6996 ymax: 40.91517
Geodetic CRS:  WGS 84
# A tibble: 262 × 7
  zip_code po_name    borough breed_rc      n     freq
  <int> <chr>      <chr>   <chr>   <int>   <dbl>
1 11372 Jackson H... Queens French ...    13 8.02e-3
2 11004 Glen Oaks  Queens French ...     1 6.17e-4
3 11040 New Hyde ... Queens <NA>       NA NA
4 11426 Bellerose   Queens French ...     1 6.17e-4
5 11365 Fresh Mea... Queens French ...     7 4.32e-3
6 11373 Elmhurst    Queens French ...    14 8.64e-3
7 11001 Floral Pa... Queens <NA>       NA NA
8 11375 Forest Hi... Queens French ...     8 4.94e-3
9 11427 Queens Vi... Queens French ...     2 1.23e-3
10 11374 Rego Park  Queens French ...    6 3.70e-3
# i 252 more rows
```

A NYC map theme

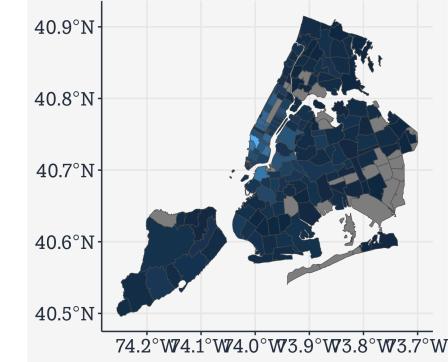
Just moving the legend, really.

```
theme_nympa <- function(base_size=9, base_family="") {  
  require(grid)  
  theme_bw(base_size=base_size, base_family=base_family) %>%  
    theme(axis.line=element_blank(),  
          axis.text=element_blank(),  
          axis.ticks=element_blank(),  
          axis.title=element_blank(),  
          panel.background=element_blank(),  
          panel.border=element_blank(),  
          panel.grid=element_blank(),  
          panel.spacing=unit(0, "lines"),  
          plot.background=element_blank(),  
          legend.justification = c(0,0),  
          legend.position = c(0.05, 0.58),  
          legend.direction = "horizontal"  
    )  
}
```

First cut at a map

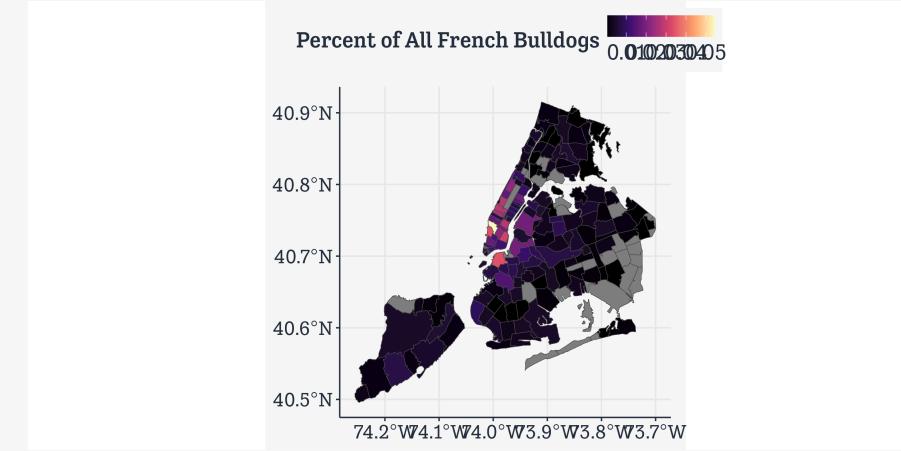
```
fb_map >  
  ggplot(mapping = aes(fill = freq)) +  
  geom_sf(color = "gray30", size = 0.1)
```

freq
0.01 0.02 0.03 0.04 0.05



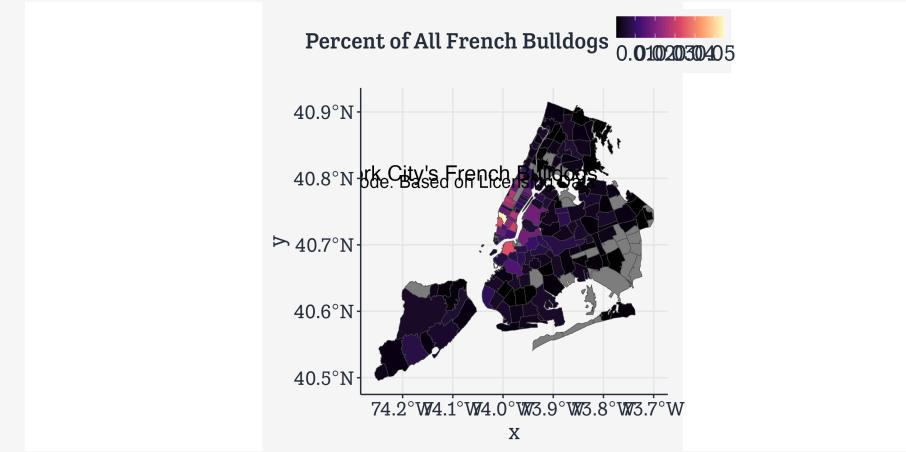
First cut at a map

```
fb_map >  
  ggplot(mapping = aes(fill = freq)) +  
  geom_sf(color = "gray30", size = 0.1) +  
  scale_fill_viridis_c(option = "A") +  
  labs(fill = "Percent of All French Bulldogs")
```



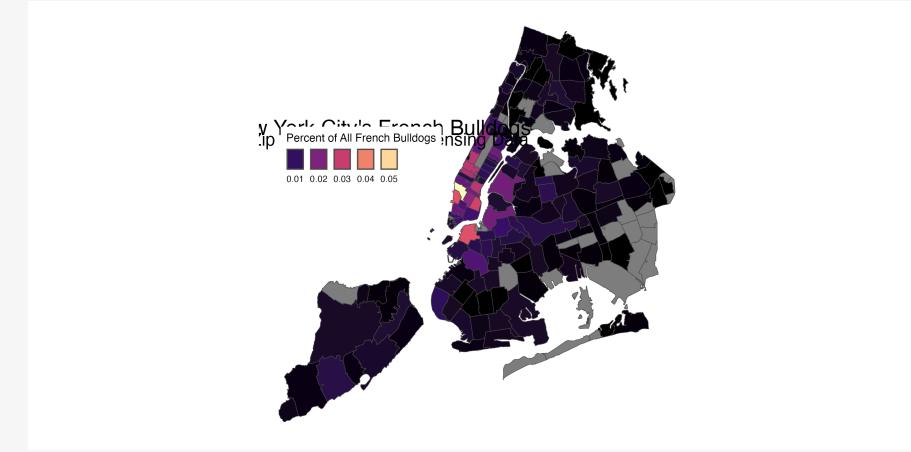
First cut at a map

```
fb_map >  
  ggplot(mapping = aes(fill = freq)) +  
  geom_sf(color = "gray30", size = 0.1) +  
  scale_fill_viridis_c(option = "A") +  
  labs(fill = "Percent of All French Bulldogs")  
  annotate(geom = "text",  
           x = -74.145 + 0.029,  
           y = 40.82-0.012,  
           label = "New York City's French Bulldog Population",  
           size = 6) +  
  annotate(geom = "text",  
           x = -74.1468 + 0.029,  
           y = 40.8075-0.012,  
           label = "By Zip Code. Based on License Plate Data",  
           size = 5)
```



First cut at a map

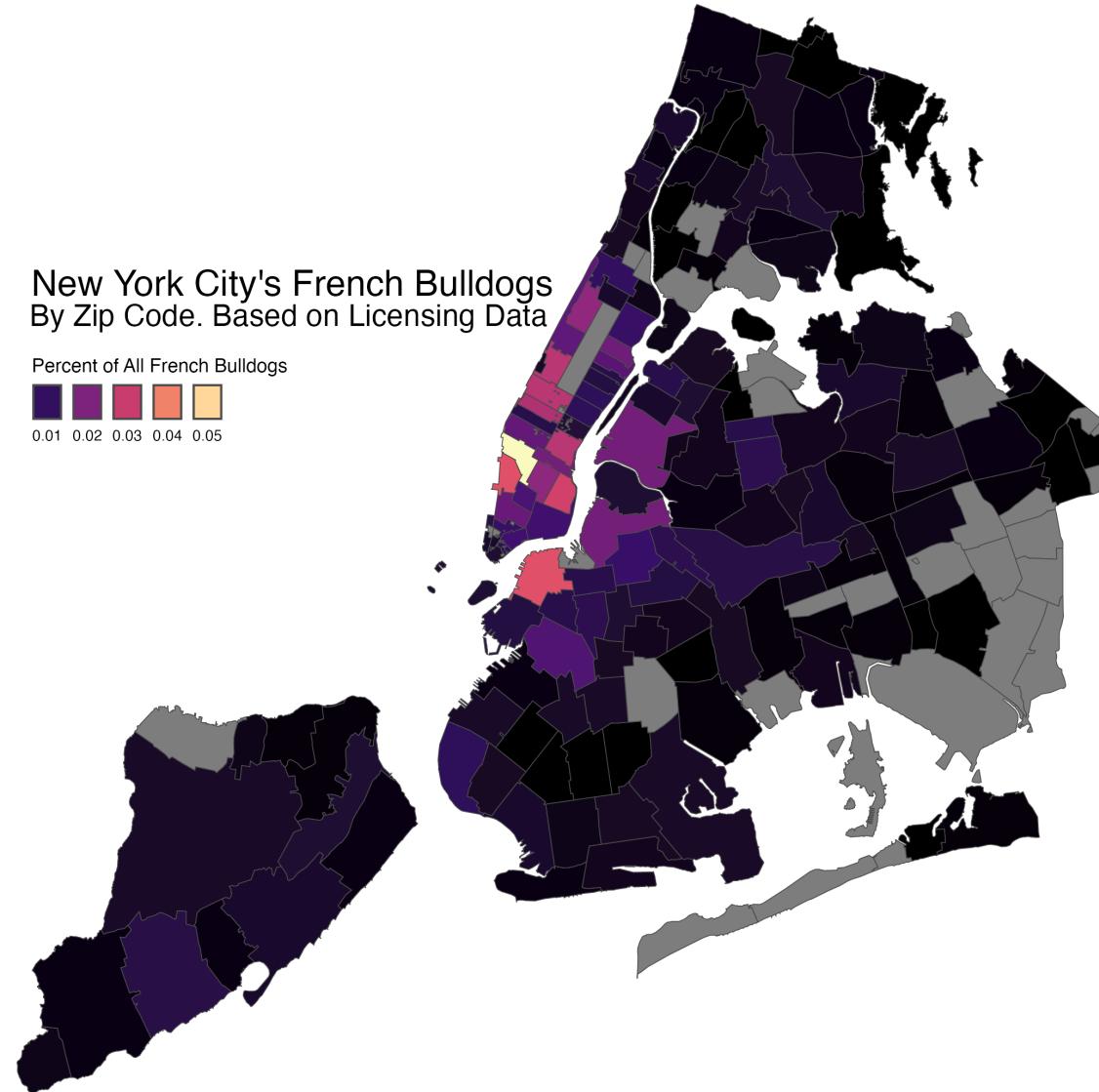
```
fb_map >
  ggplot(mapping = aes(fill = freq)) +
  geom_sf(color = "gray30", size = 0.1) +
  scale_fill_viridis_c(option = "A") +
  labs(fill = "Percent of All French Bulldogs")
  annotate(geom = "text",
           x = -74.145 + 0.029,
           y = 40.82-0.012,
           label = "New York City's French Bulldog Licensing Data",
           size = 6) +
  annotate(geom = "text",
           x = -74.1468 + 0.029,
           y = 40.8075-0.012,
           label = "By Zip Code. Based on Licensing Data",
           size = 5) +
kjhslides::kjh_theme_nymap() +
guides(fill =
  guide_legend(title.position = "top",
               label.position = "bottom",
               keywidth = 1,
               nrow = 1))
```



New York City's French Bulldogs By Zip Code. Based on Licensing Data

Percent of All French Bulldogs

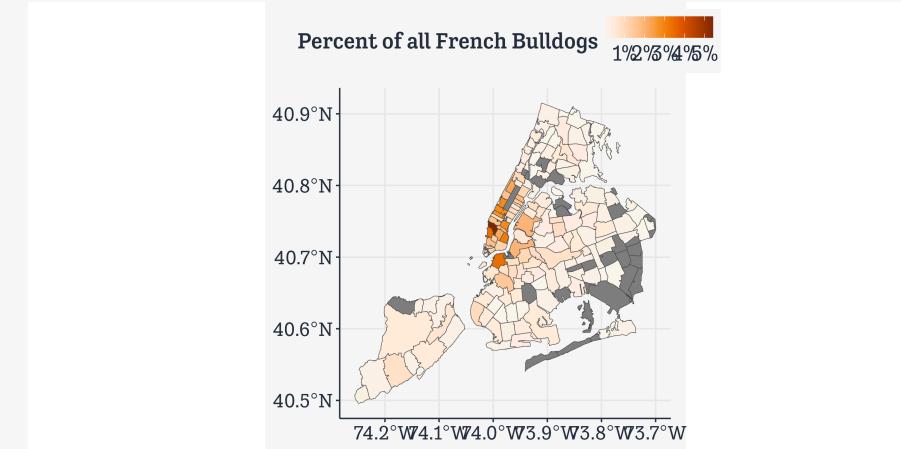
0.01 0.02 0.03 0.04 0.05



Use a different palette

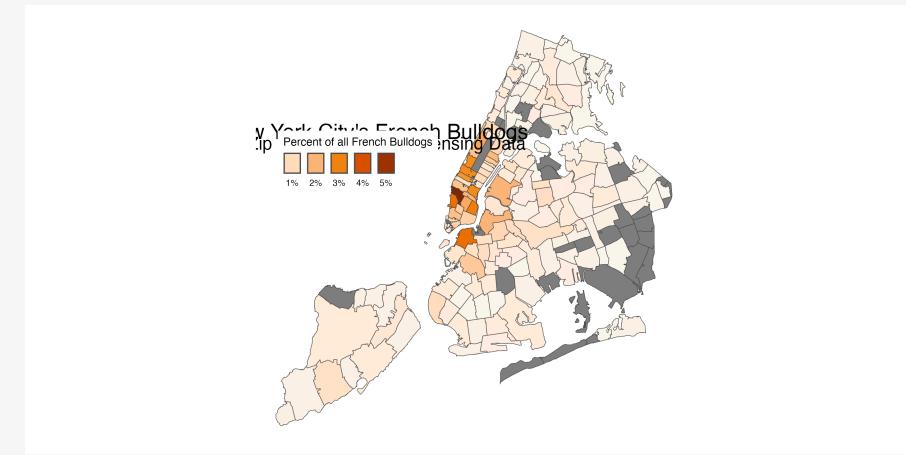
```
library(colorspace)

fb_map >
  ggplot(mapping = aes(fill = freq)) +
  geom_sf(color = "gray30", size = 0.1) +
  scale_fill_continuous_sequential(
    palette = "Oranges",
    labels = scales::label_percent()) +
  labs(fill = "Percent of all French Bulldogs")
```



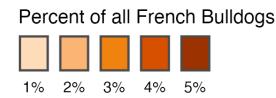
Use a different palette

```
fb_map >
  ggplot(mapping = aes(fill = freq)) +
  geom_sf(color = "gray30", size = 0.1) +
  scale_fill_continuous_sequential(
    palette = "Oranges",
    labels = scales::label_percent()) +
  labs(fill = "Percent of all French Bulldogs")
  annotate(geom = "text",
    x = -74.145 + 0.029,
    y = 40.82-0.012,
    label = "New York City's French Bulldogs",
    size = 6) +
  annotate(geom = "text",
    x = -74.1468 + 0.029,
    y = 40.7955,
    label = "By Zip Code. Based on Licensing Data",
    size = 5) +
  kjhslides::kjh_theme_nymap() +
  guides(fill =
    guide_legend(title.position = "top",
      label.position = "bottom",
      keywidth = 1,
```

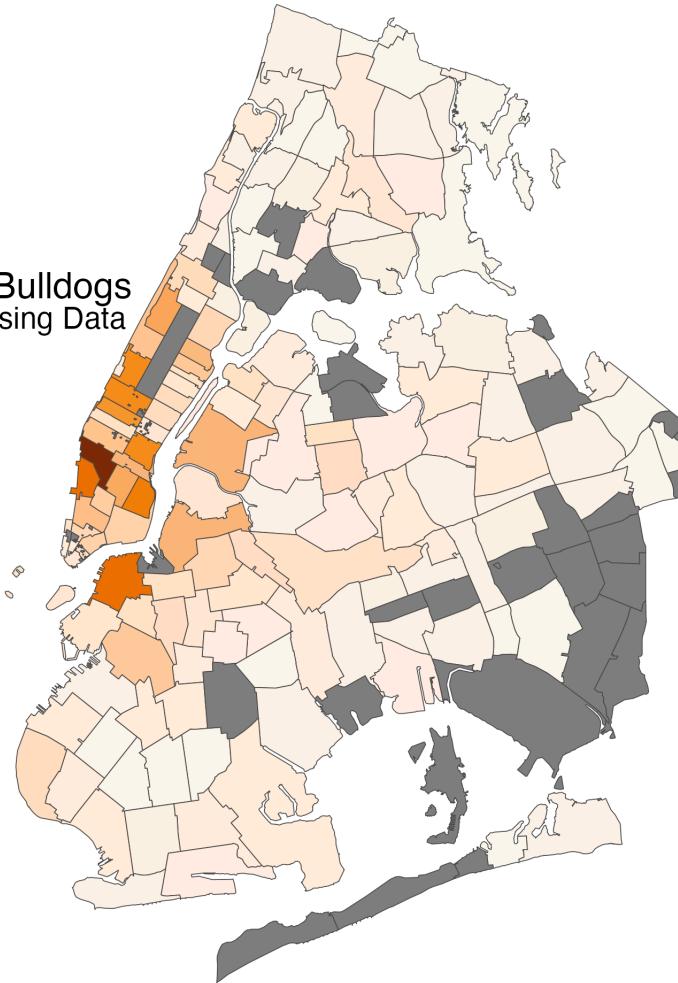


New York City's French Bulldogs By Zip Code. Based on Licensing Data

Percent of all French Bulldogs



Percent Range	Color
1%	Lightest Tan
2%	Light Tan
3%	Medium Tan
4%	Dark Tan
5%	Darkest Tan



NYC Dogs Map mark 2

Keep the Zero-count Zips

```
nyc_license %>  
  filter(extract_year == 2018) %>  
  group_by(breed_rc, zip_code) %>  
  tally() %>  
  ungroup() %>  
  complete(zip_code, breed_rc,  
           fill = list(n = 0)) %>  
  # Regroup to get the right denominator  
  group_by(breed_rc) %>  
  mutate(freq = n / sum(n)) %>  
  filter(breed_rc == "French Bulldog") %>  
  nyc_fb2  
  
fb_map2 <- left_join(nyc_zips,  
                      nyc_fb2,  
                      by = "zip_code")
```

Keep the Zero-count Zips

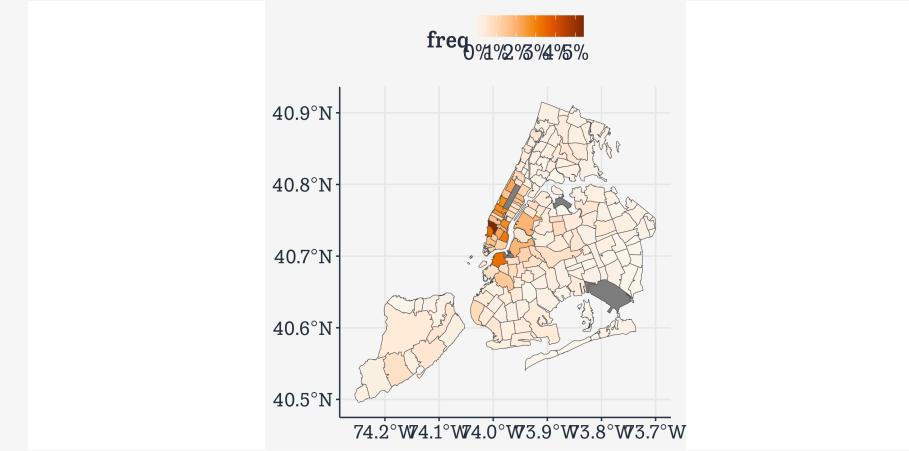
```
fb_map2 ▶ select(zip_code, po_name, borough, breed_rc:freq, geometry)
```

```
Simple feature collection with 262 features and 6 fields
Geometry type: POLYGON
Dimension:     XY
Bounding box:  xmin: -74.25576 ymin: 40.49584 xmax: -73.6996 ymax: 40.91517
Geodetic CRS:  WGS 84
# A tibble: 262 × 7
  zip_code po_name    borough breed_rc      n    freq
  <int> <chr>      <chr>   <chr> <int>  <dbl>
1 11372 Jackson He... Queens French ... 13 8.02e-3
2 11004 Glen Oaks    Queens French ... 1 6.17e-4
3 11040 New Hyde P... Queens French ... 0 0
4 11426 Bellerose    Queens French ... 1 6.17e-4
5 11365 Fresh Mead... Queens French ... 7 4.32e-3
6 11373 Elmhurst     Queens French ... 14 8.64e-3
7 11001 Floral Park Queens French ... 0 0
8 11375 Forest Hil... Queens French ... 8 4.94e-3
9 11427 Queens Vil... Queens French ... 2 1.23e-3
10 11374 Rego Park   Queens French ... 6 3.70e-3
# i 252 more rows
```

This time, a number of previous **NA** rows are now zeroes instead.

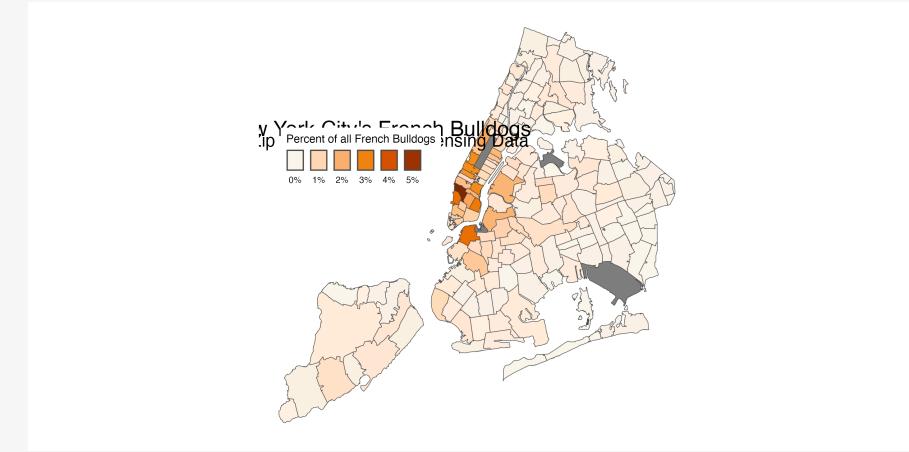
Keep the Zero-count Zips

```
fb_map2 >  
  ggplot(mapping = aes(fill = freq)) +  
  geom_sf(color = "gray30", size = 0.1) +  
  scale_fill_continuous_sequential(  
    palette = "Oranges",  
    labels = scales::label_percent())
```



Keep the Zero-count Zips

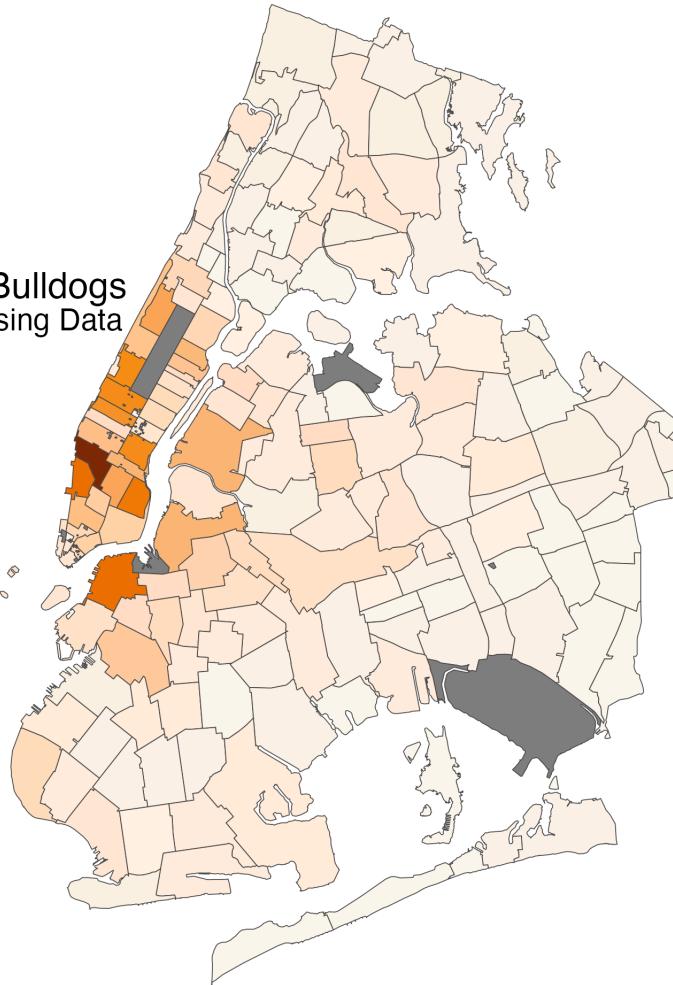
```
fb_map2 >
  ggplot(mapping = aes(fill = freq)) +
  geom_sf(color = "gray30", size = 0.1) +
  scale_fill_continuous_sequential(
    palette = "Oranges",
    labels = scales::label_percent()) +
  labs(fill = "Percent of all French Bulldogs")
  annotate(geom = "text",
    x = -74.145 + 0.029,
    y = 40.82-0.012,
    label = "New York City's French Bulldog Licensing Data",
    size = 6) +
  annotate(geom = "text",
    x = -74.1468 + 0.029,
    y = 40.7955,
    label = "By Zip Code. Based on License Plate Data",
    size = 5) +
  kjhslides::kjh_theme_nymap() +
  guides(fill =
    guide_legend(title.position = "top",
                label.position = "bottom",
                keywidth = 1,
```



New York City's French Bulldogs By Zip Code. Based on Licensing Data

Percent of all French Bulldogs

0% 1% 2% 3% 4% 5%



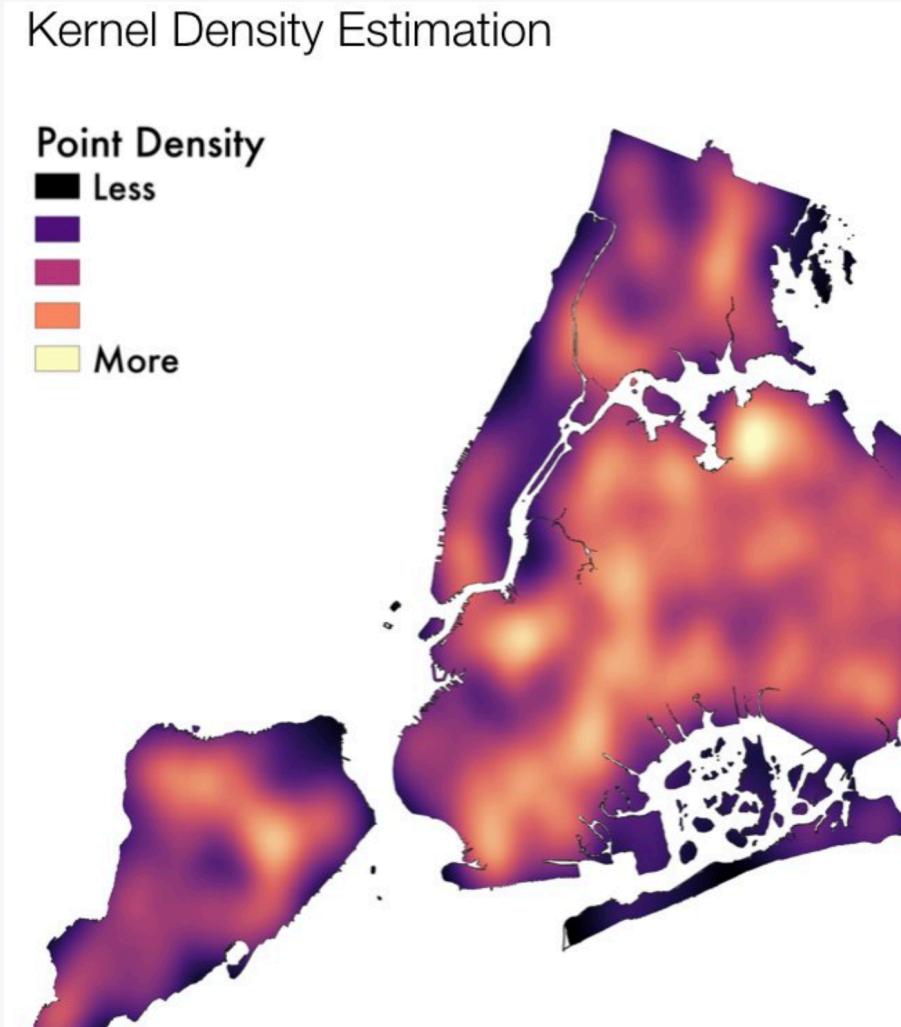
Zero areas properly zero, missing areas properly missing.

Care with Spatial Distribution



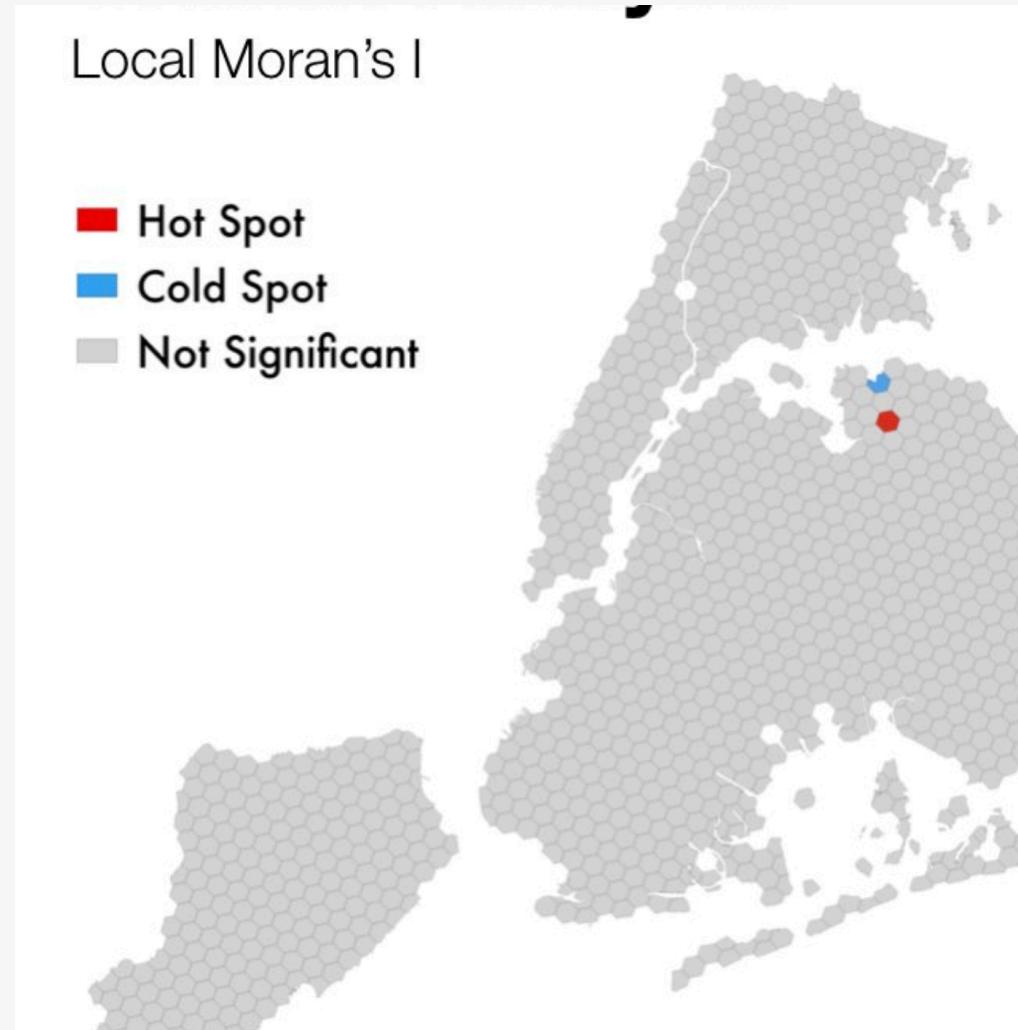
A random point-process

Care with Spatial Distribution



A heatmap derived from the random process

Care with Spatial Distribution



A formal test of significant hotspots

Example: Dorling Cartograms

Dorling Cartograms

```
# install.packages("cartogram")
library(cartogram)
options(tigris_use_cache = TRUE)
```

Dorling Cartograms

```
pop_names ← tribble(  
  ~varname, ~clean,  
  "B01003_001", "pop",  
  "B01001B_001", "black",  
  "B01001A_001", "white",  
  "B01001H_001", "nh_white",  
  "B01001I_001", "hispanic",  
  "B01001D_001", "asian"  
)
```

```
pop_names
```

```
# A tibble: 6 × 2  
  varname    clean  
  <chr>      <chr>  
1 B01003_001 pop  
2 B01001B_001 black  
3 B01001A_001 white  
4 B01001H_001 nh_white  
5 B01001I_001 hispanic  
6 B01001D_001 asian
```

Dorling Cartograms

```
library(tidycensus)
fips_pop ← get_acs(geography = "county",
                     variables = pop_names$varname,
                     cache_table = TRUE) ▷
  left_join(pop_names, join_by(variable = varname)) ▷
  mutate(variable = clean) ▷
  select(-clean, -moe) ▷
  pivot_wider(names_from = variable, values_from = estimate) ▷
  rename(fips = GEOID, name = NAME) ▷
  mutate(prop_pop = pop/sum(pop),
        prop_black = black/pop,
        prop_hisp = hispanic/pop,
        prop_white = white/pop,
        prop_nhwhite = nh_white/pop,
        prop_asian = asian/pop)

fips_map ← get_acs(geography = "county",
                     variables = "B01001_001",
                     geometry = TRUE,
                     shift_geo = FALSE,
                     cache_table = TRUE) ▷
  select(GEOID, NAME, geometry) ▷
```

Dorling Cartograms

```
pop_cat_labels ← c("<5", as.character(seq(10, 95, 5)), "100")

counties_sf ← fips_map ▷
  left_join(fips_pop, by = c("fips", "name")) ▷
  mutate(black_disc = cut(prop_black*100,
                          breaks = seq(0, 100, 5),
                          labels = pop_cat_labels,
                          ordered_result = TRUE),
         hisp_disc = cut(prop_hisp*100,
                          breaks = seq(0, 100, 5),
                          labels = pop_cat_labels,
                          ordered_result = TRUE),
         nhwhite_disc = cut(prop_nhwhite*100,
                             breaks = seq(0, 100, 5),
                             labels = pop_cat_labels,
                             ordered_result = TRUE),
         asian_disc = cut(prop_asian*100,
                           breaks = seq(0, 100, 5),
                           labels = pop_cat_labels,
                           ordered_result = TRUE)) ▷
  sf::st_transform(crs = 2163)
```

Dorling Cartograms

```
counties_sf
```

Simple feature collection with 3222 features and 18 fields

Geometry type: MULTIPOLYGON

Dimension: XY

Bounding box: xmin: -6433624 ymin: -2354597 xmax: 3667987 ymax: 3912355

Projected CRS: NAD27 / US National Atlas Equal Area

First 10 features:

	fips	name	white	black	asian	nh_white	hispanic	pop
1	01069	Houston County, Alabama	71260	29166	987	69420	3844	107040
2	01023	Choctaw County, Alabama	7180	5062	15	7162	143	12669
3	01005	Barbour County, Alabama	11309	11668	126	11084	1202	24877
4	01107	Pickens County, Alabama	10880	7506	10	10141	987	18925
5	01033	Colbert County, Alabama	44698	9185	214	44485	1837	57270
	prop_pop	prop_black	prop_hisp	prop_white	prop_nhwhite	prop_asian		
1	3.201244e-04	0.2724776	0.03591181	0.6657324	0.6485426	0.0092208520		
2	3.788917e-05	0.3995580	0.01128739	0.5667377	0.5653169	0.0011839924		
3	7.439962e-05	0.4690276	0.04831772	0.4545966	0.4455521	0.0050649194		
4	5.659898e-05	0.3966182	0.05215324	0.5749009	0.5358520	0.0005284016		
5	1.712773e-04	0.1603807	0.03207613	0.7804784	0.7767592	0.0037366859		

geometry black_disc hisp_disc nhwhite_disc asian_disc

Dorling Cartograms

```
## Be patient
county_dorling ← cartogram_dorling(x = counties_sf,
  weight = "prop_pop",
  k = 0.2, itermax = 100)

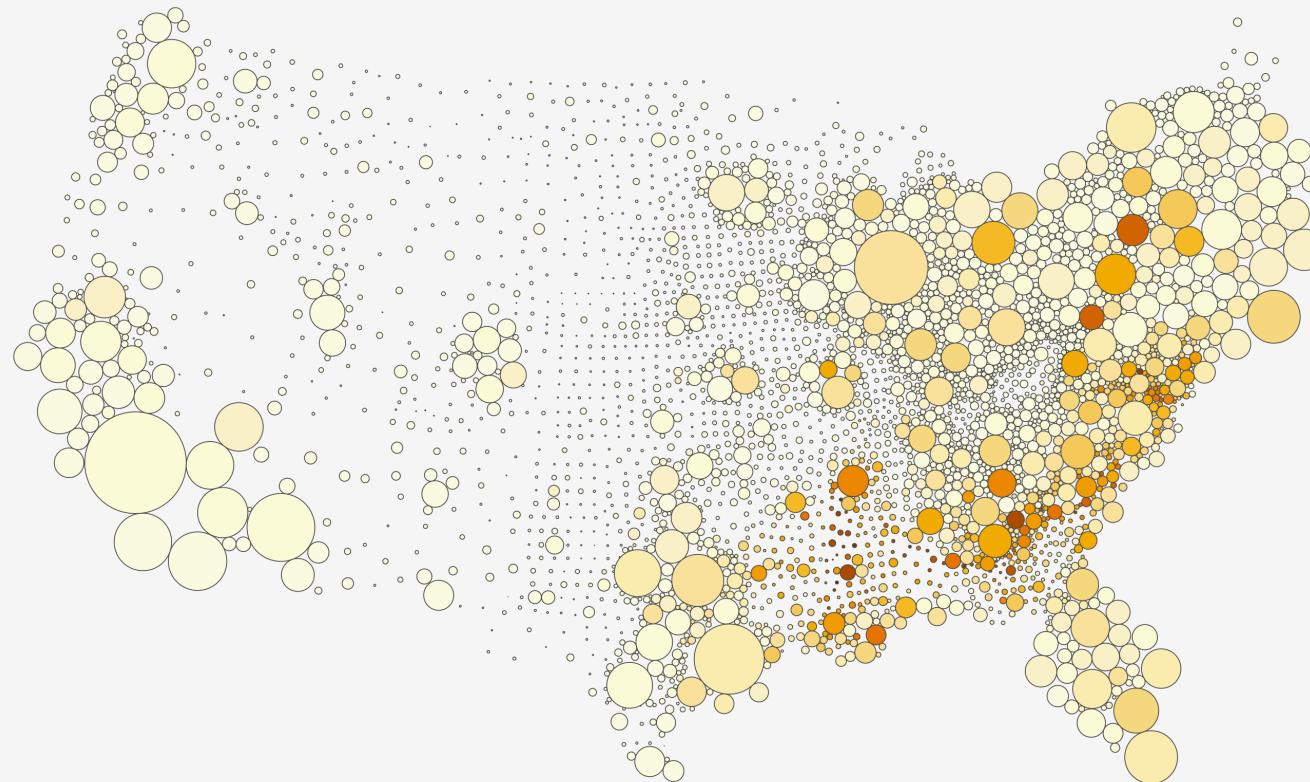
out_black ← county_dorling %>
  filter(!str_detect(name, "Alaska|Hawaii|Puerto|Guam")) %>
  ggplot(aes(fill = black_disc)) +
  geom_sf(color = "grey30", size = 0.1) +
  coord_sf(crs = 2163, datum = NA) +
  scale_fill_discrete_sequential(palette = "YlOrBr",
                                  na.translate=FALSE) +
  guides(fill = guide_legend(title.position = "top",
                             label.position = "bottom",
                             nrow = 1)) +
  labs(
    subtitle = "Bubble size corresponds to County Population",
    caption = "Graph: @kjhealy. Source: Census Bureau / American Community Survey",
    fill = "Percent Black by County") +
  theme(legend.position = "top",
        legend.spacing.x = unit(0, "cm"),
        legend.title = element_text(size = rel(1.5), face = "bold"))
```

Dorling Cartograms

```
print(out_black)
```

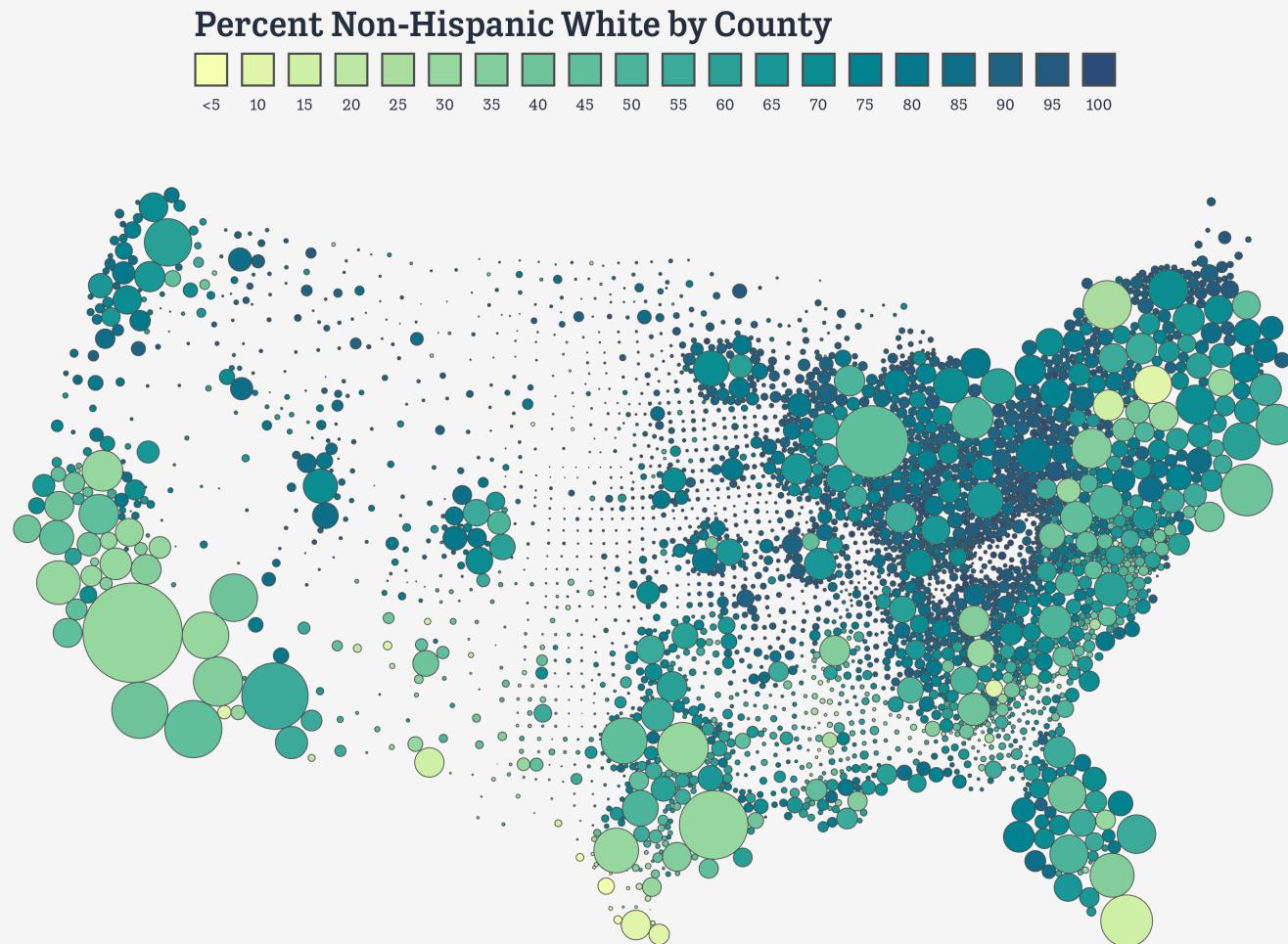
Bubble size corresponds to County Population

Percent Black by County

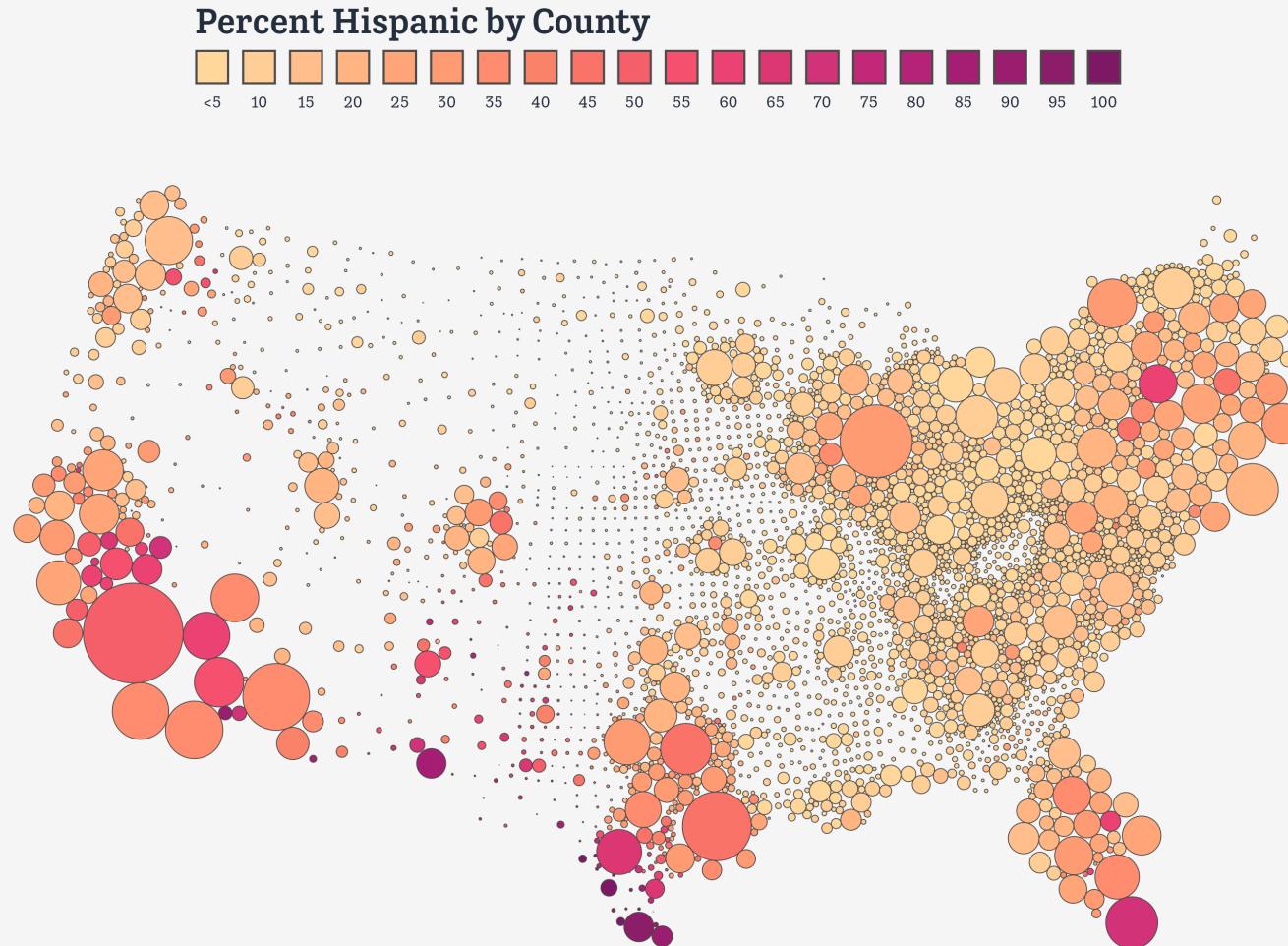


Graph: @kjhealy. Source: Census Bureau / American Community Survey

```
print(out_white)
```



```
print(out_hispanic)
```



```
print(out_asian)
```

