Millbank Indices Code

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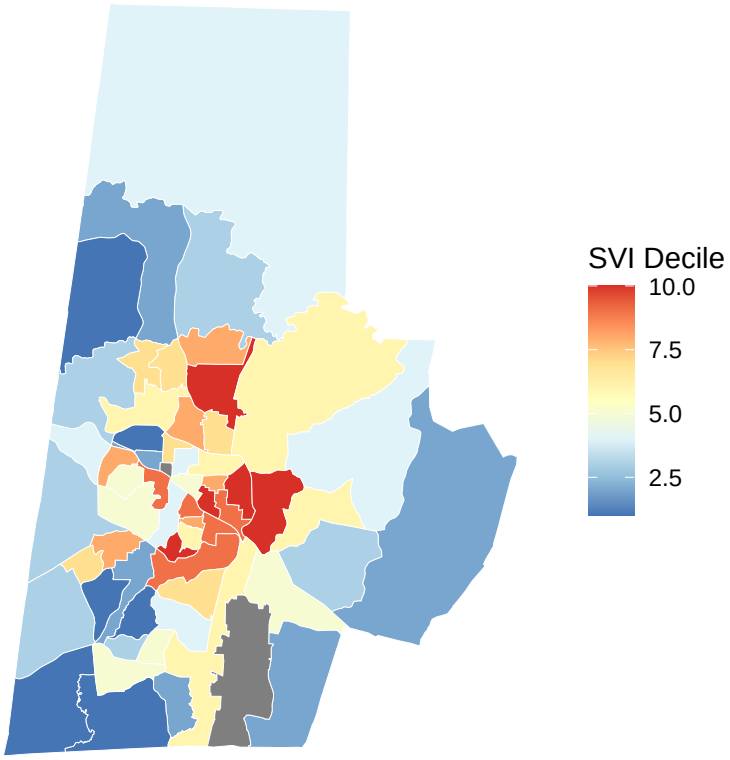
```
  library(ggsn)
  library(dplyr)
  library(tidyr, tidyverse)
  library(tmap)
  library(ggplot2)
  library(rnaturalearth)
  library(sf)
  library(maps)
  library(maptools)
  library(rgdal)
  library(RColorBrewer)
  library(readxl)
  library(ggsn)
  library(tigris)
  library(ggspatial)
  library(spatstat)
  library(GGally)
  library(spdep)
  library(spdep)
  library(tmap)
  library(readr)
  library(foreach)
library(tigris)
```

```
# Load census tract simple feature data
durham_tracts = tigris::tracts(county = 063, state = "NC", year = 2010)
cookcounty_ct = tigris::tracts(county = 031, state = "IL", year = 2010) %>%
  filter(GEOID10!="17031990000")
orleans_ct = tigris::tracts(county = 071, state = "LA", year = 2010)  %>%
  filter(GEOID10!="22071980000" & GEOID10!="22071990000")

#Load block group simple feature data
durham_bg = tigris::block_groups(county=063, state="NC", year = 2010)
cookcounty_bg = tigris::block_groups(county=031, state="IL", year = 2010) %>%
  filter(GEOID10!="170319900000")
orleans_bg = tigris::block_groups(county = 071, state = "LA", year = 2010) %>%
          filter(GEOID10!="22071980001" & GEOID10!="220719801001" & GEOID10!="220719900000")

# Convert GEOID variable from character to numeric
durham_tracts$fips = as.numeric(durham_tracts$GEOID10)
durham_bg$fips = as.numeric(durham_bg$GEOID10)
cookcounty_bg$fips = as.numeric(cookcounty_bg$GEOID10)
```

```
cookcounty_ct$fips = as.numeric(cookcounty_ct$GEOID10)
orleans_ct$fips = as.numeric(orleans_ct$GEOID10)
orleans_bg$fips = as.numeric(orleans_bg$GEOID10)

# Load Durham indices data
svi_durham <- read_csv("data/svi_durham.csv")
adi_durham <- read_csv("data/adi_durham.csv")
ccvi_durham <- read_csv("data/ccvi_durham.csv")
coi_durham  <- read_csv("data/coi_durham.csv")

# Load Chicago indices data
svi_chicago  <- read_csv("data/svi_chicago.csv")
adi_chicago  <- read_csv("data/adi_chicago.csv")
ccvi_chicago <- read_csv("data/ccvi_chicago.csv")
coi_chicago  <- read_csv("data/coi_chicago.csv")

# Load NOLA indices data
svi_nola  <- read_csv("data/svi_nola.csv")
adi_nola  <- read_csv("data/adi_nola.csv")
ccvi_nola <- read_csv("data/ccvi_nola.csv")
coi_nola <- read_csv("data/coi_nola.csv")

# Load block group population information
durham_19ct_totalpop <- read_csv("data/durham_19ct_totalpop.csv") %>%
  filter(STATEA == 37 & COUNTYA==063)
us_tracts_2019 <- read_csv("data/us_tracts_2019.csv")

# Load datasets with all indices
all_durham <- read_csv("data/all_durham.csv")
all_cookcounty <- read_csv("data/all_cookcounty.csv", col_types = cols(fips = col_character()))
all_nola <- read_csv("data/all_nola.csv", col_types = cols(fips = col_character()))
```

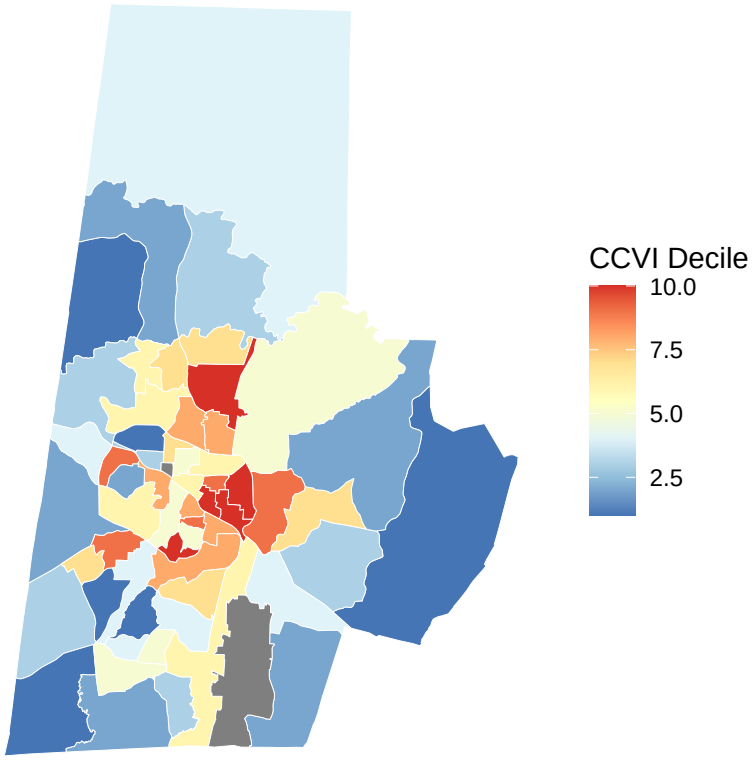
Map Durham SVI

```
# Merge census tract shape file with Durham
mapdata_svi_d <- merge(durham_tracts, svi_durham, by.x="GEOID10", by.y="fips", all.x=TRUE)

# Create decile of data
mapdata_svi_d$svi_dec = ntile(mapdata_svi_d$sviscore, 10)

# Map the decile data
map_svi <- ggplot(data = mapdata_svi_d) + geom_sf(aes(fill = svi_dec), size=0.005, color="white") +
  scale_fill_distiller(palette = "RdYlBu", name="SVI Decile")

# Set map theme to be used for all maps
map_theme = theme(panel.background = element_blank(), panel.grid.major = element_blank(), panel.grid.mi
                  axis.ticks = element_blank(),
                  axis.title.x = element_blank(), axis.title.y = element_blank(),
                  axis.text.x = element_blank(), axis.text.y = element_blank())

# Create map
map_svi + map_theme
```



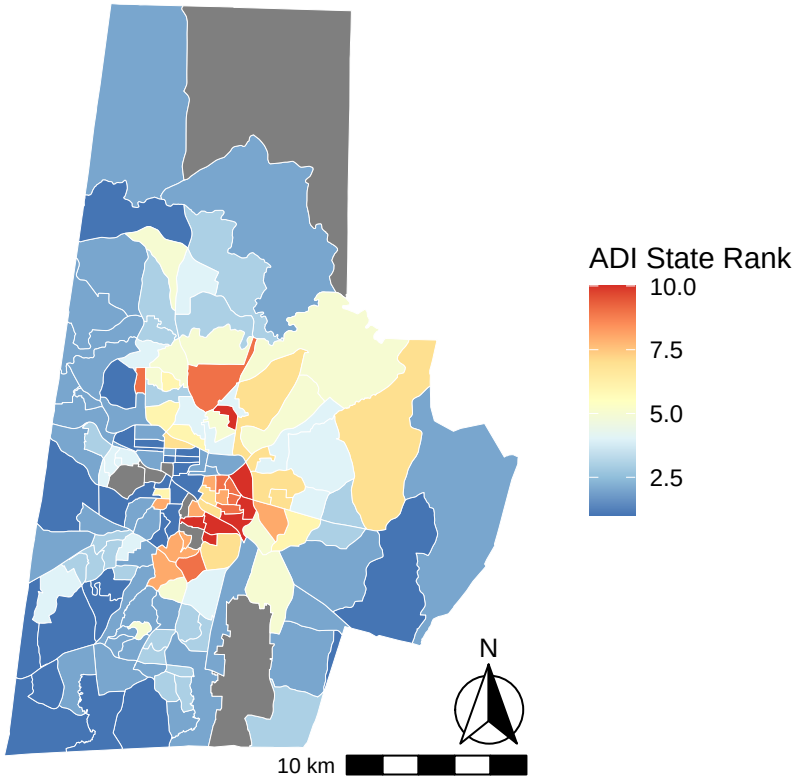
Map Durham CCVI

```
# Merge census shape file with CCVI
ccvi_durham <- ccvi_durham %>%
  mutate(fips = as.character(fips)) %>%
  rename(GEOID10 = fips)
mapdata_ccvi_d <- full_join(durham_tracts, ccvi_durham, by ="GEOID10")

# Create decile of data
mapdata_ccvi_d$ccvi_dec = ntile(mapdata_ccvi_d$ccvi, 10)

# Map the data
map_ccvi_d <- ggplot(data = mapdata_ccvi_d) + geom_sf(aes(fill = ccvi_dec), size=0.005, color="white") +
scale_fill_distiller(palette = "RdYlBu", name="CCVI Decile")
map_ccvi_d + map_theme
```



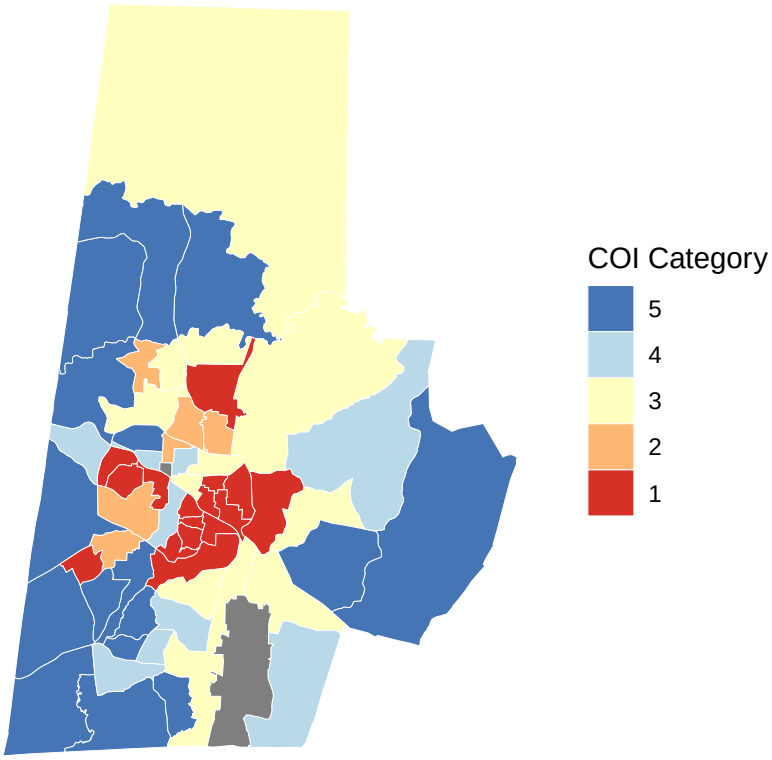
Map Durham ADI

```
# Merge block group shape file with ADI
durham_bg <- durham_bg %>%
  mutate(GEOID10 = as.numeric(GEOID10)) %>%
  rename(FIPS = GEOID10)
mapdata_adi_d = left_join(durham_bg, adi_durham, by="FIPS")

# Map the data
map_adi_d <- ggplot(data=mapdata_adi_d) + geom_sf(aes(fill = ADI_STATERNK), size=0.005, color="white") +
          scale_fill_distiller(palette = "RdYlBu", name="ADI State Rank")

map_adi_d + map_theme + annotation_scale(location = "br", width_hint = 0.4) +
          annotation_north_arrow(location = "br", which_north = "true",
                                 pad_x = unit(0.0, "in"), pad_y = unit(0.2, "in"),
                                 style = north_arrow_fancy_orienteering)
```



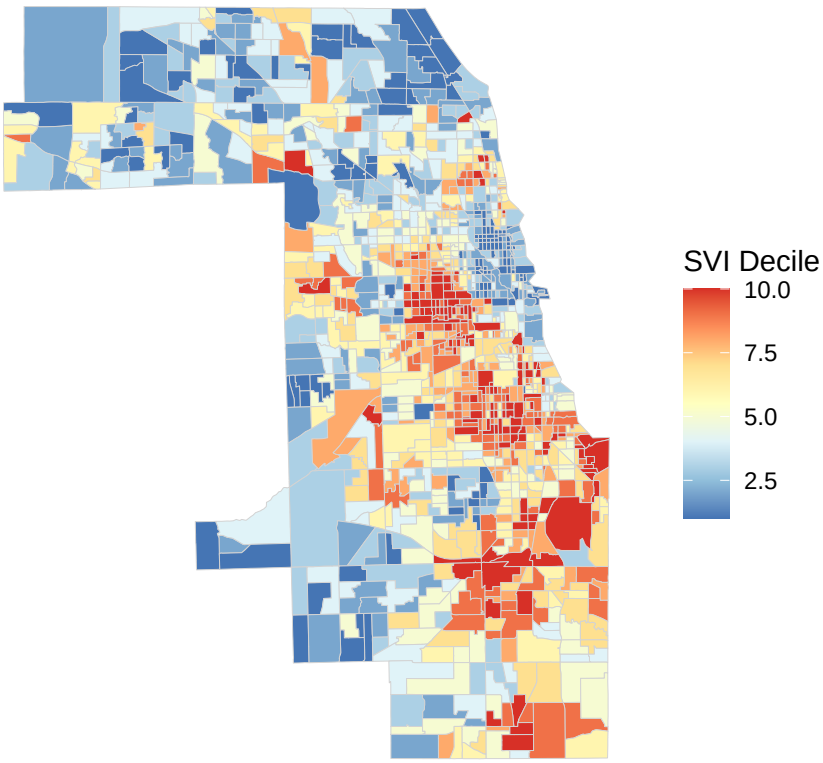
Map Durham COI

```
# Merge CENSUS TRACT shape file with COI
    mapdata_coi_d = left_join(durham_tracts, coi_durham, by="fips") %>%
          mutate(risk_cat = recode(c5_COI_stt,
                                   "Very High" = 5,
                                   "High" = 4,
                                   "Moderate" = 3,
                                   "Low" = 2,
                                   "Very Low" = 1
          ))

# Map the data
map_coi_d = ggplot(data = mapdata_coi_d) + geom_sf(aes(fill = risk_cat), size=0.005, color="white") +
          scale_fill_distiller(palette = "RdYlBu", trans="reverse", limits = c(5,1))

map_theme = theme(panel.background = element_blank(), panel.grid.major = element_blank(), panel.grid.mi
                  element_blank(), axis.ticks = element_blank(),
                          axis.title.x = element_blank(), axis.title.y = element_blank(),
                          axis.text.x = element_blank(), axis.text.y = element_blank())

map_coi_d + map_theme + guides(fill=guide_legend(title="COI Category", reverse=TRUE))
```



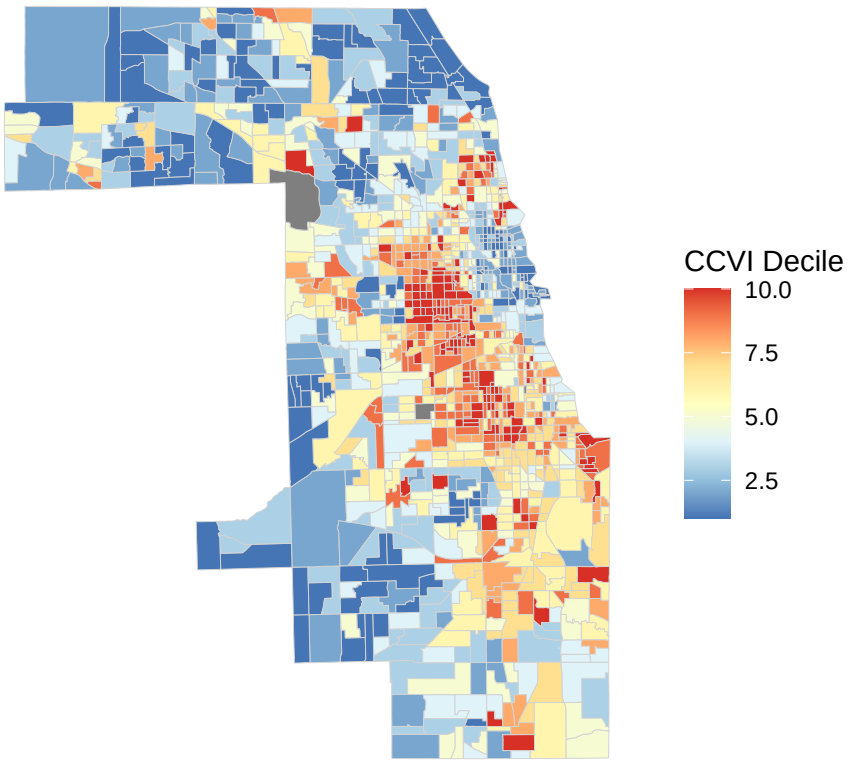
Map Chicago SVI

```
# Merge census tract shape file with SVI
cookcounty_ct$FIPS = as.numeric(cookcounty_ct$GEOID10)
mapdata_svi_c = merge(cookcounty_ct, svi_chicago, by = "FIPS")

# Create decile of data
mapdata_svi_c$svi_dec = ntile(mapdata_svi_c$RPL_THEMES, 10)

# Map the decile data
map_svi_c = ggplot(data = mapdata_svi_c) + geom_sf(aes(fill = svi_dec), size=0.005, color="light grey")
          scale_fill_distiller(palette = "RdYlBu", name="SVI Decile")

map_svi_c + map_theme
```



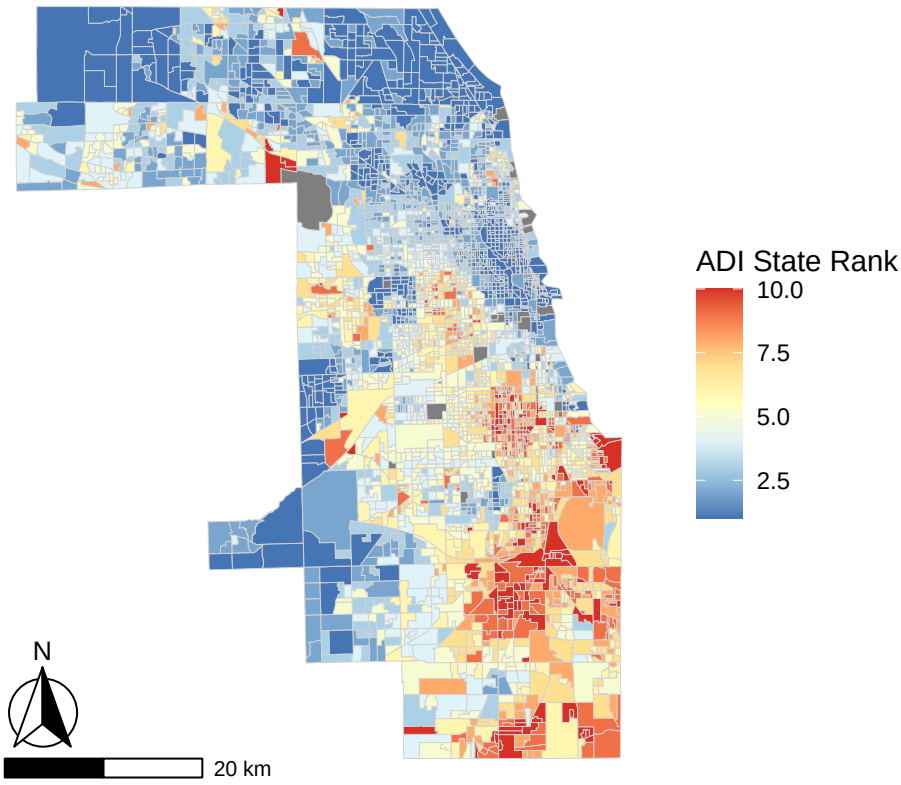
Map Chicago CCVI

```
# Merge census tract shape file with CCVI
ccvi_chicago$ccvi = as.numeric(ccvi_chicago$ccvi)
ccvi_chicago$fips = as.numeric(ccvi_chicago$FIPS)
mapdata_ccvi_c = left_join(cookcounty_ct, ccvi_chicago, by="fips")

 # Create decile of data
mapdata_ccvi_c$ccvi_dec = ntile(mapdata_ccvi_c$ccvi, 10)

# Map the data
map_ccok_ccvi = ggplot(data = mapdata_ccvi_c) + geom_sf(aes(fill = ccvi_dec), size=0.005, color="light
scale_fill_distiller(palette = "RdYlBu", name="CCVI Decile")

map_ccok_ccvi + map_theme
```



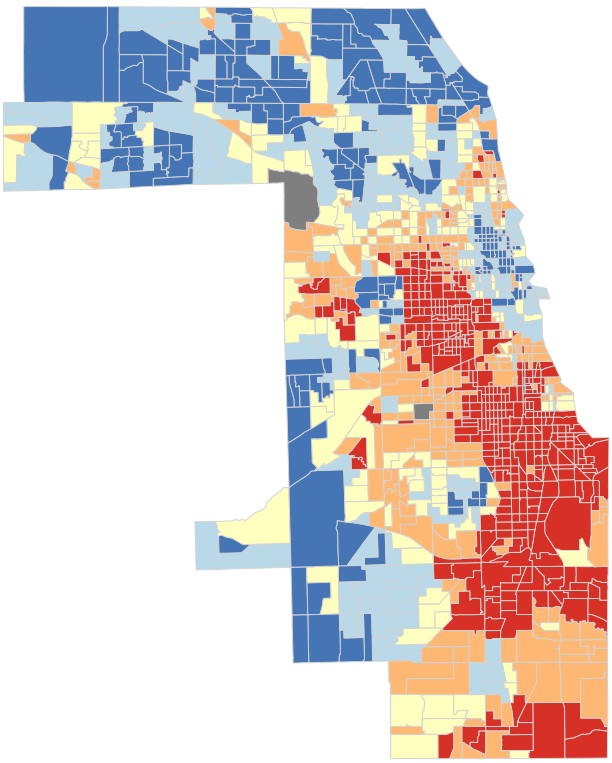
Map Chicago ADI

```
# Merge block group shape file with ADI
adi_chicago$fips = as.numeric(adi_chicago$FIPS)
adi_chicago$adi_strnk = as.numeric(adi_chicago$ADI_STATERNK)
mapdata_adi_c = left_join(cookcounty_bg, adi_chicago, by="fips")

# Map the data
map_adi_c = ggplot(data=mapdata_adi_c ) + geom_sf(aes(fill = adi_strnk), size=0.0005, color="light grey
scale_fill_distiller(palette = "RdYlBu", name="ADI State Rank")
map_adi_c + map_theme +  annotation_scale(location = "bl", width_hint = 0.4) +
          annotation_north_arrow(location = "bl", which_north = "true",
                                 pad_x = unit(0.0, "in"), pad_y = unit(0.2, "in"),
                                 style = north_arrow_fancy_orienteering)
```



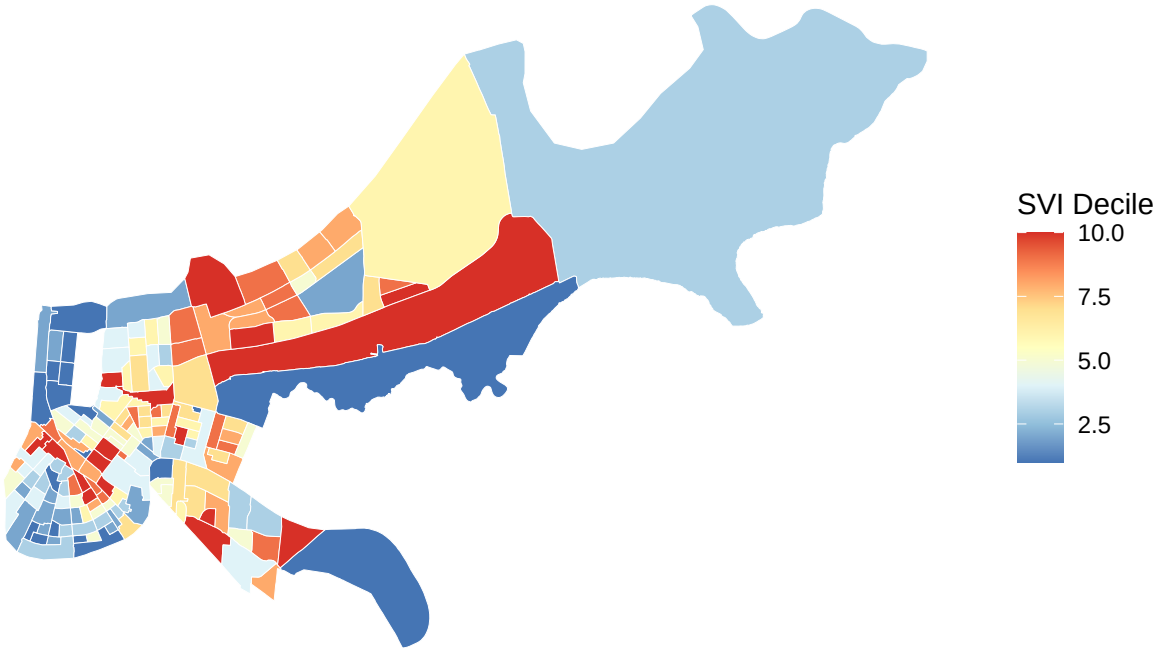
Map Chicago COI

```
# Merge census tract shape file with COI
mapdata_coi_c = left_join(cookcounty_ct, coi_chicago, by="fips") %>%
  mutate(risk_cat_c = recode(c5_COI_stt,
                             "Very High" = 5,
                              "High" = 4,
                              "Moderate" = 3,
                              "Low" = 2,
                              "Very Low" = 1))

# Map the data
map_coi_c <- ggplot(data = mapdata_coi_c) + geom_sf(aes(fill = risk_cat_c), size=0.005, color="light gr
  scale_fill_distiller(palette = "RdYlBu", trans = "reverse", limits = c(5,1))

map_coi_c + map_theme + guides(fill=guide_legend(title="COI Category", reverse=TRUE))
```



Map New Orleans SVI

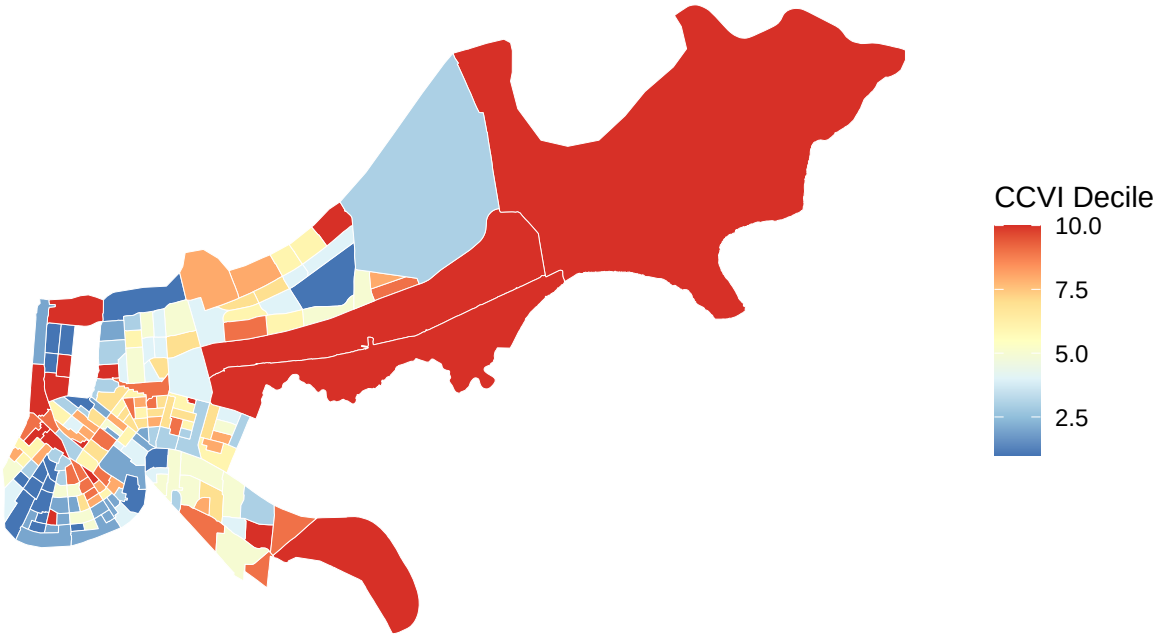
```
# Merge census tract shape file with SVI
svi_nola$fips = as.numeric(svi_nola$FIPS)
mapdata_svi_n = left_join(orleans_ct, svi_nola, by="fips")

# Create decile of data
mapdata_svi_n$svi_dec = ntile(mapdata_svi_n$RPL_THEMES, 10)

# Map the data
map_svi_n = ggplot(data = mapdata_svi_n) + geom_sf(aes(fill = svi_dec), size=0.005, color="white") +
  scale_fill_distiller(palette = "RdYlBu", name="SVI Decile")
map_svi_n + map_theme
```



Map

New Orleans CCVI

```
# Merge census tract shape file with CCVI
ccvi_nola$fips = as.numeric(ccvi_nola$FIPS)
mapdata_ccvi_n = left_join(orleans_ct, ccvi_nola, by="fips")

# Create decile of data
mapdata_ccvi_n$ccvi_dec = ntile(mapdata_ccvi_n$ccvi, 10)

# Map the decile data
map_ccvi_orleans = ggplot(data = mapdata_ccvi_n) + geom_sf(aes(fill = ccvi_dec), size=0.005, color="whi
  scale_fill_distiller(palette = "RdYlBu", name="CCVI Decile")
map_ccvi_orleans + map_theme
```

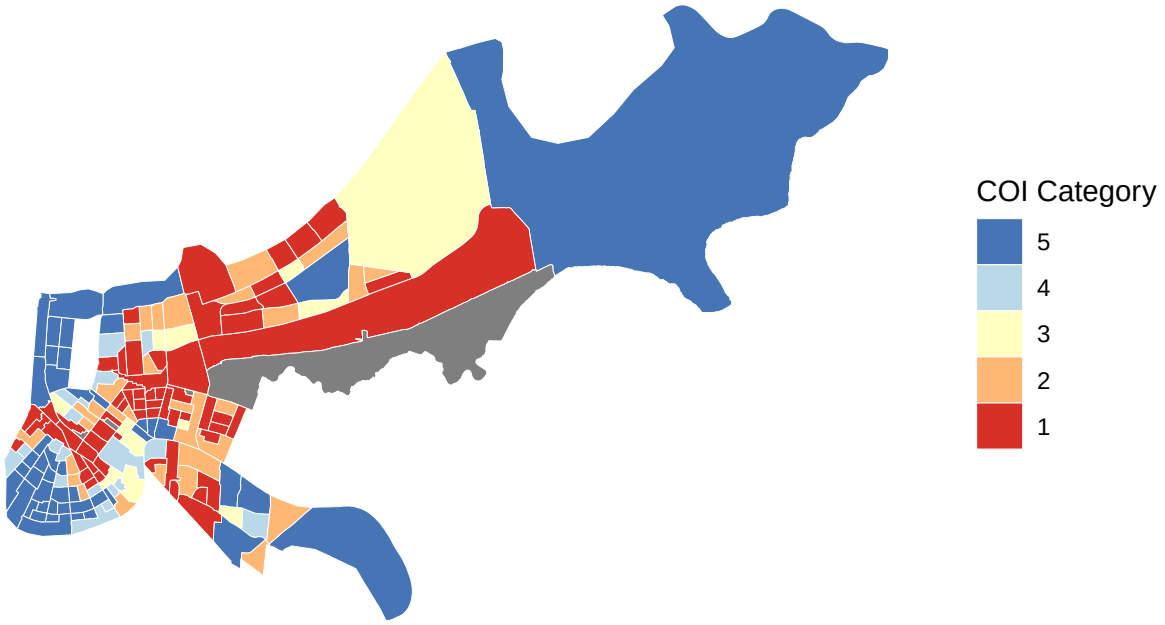


#Map New Orleans ADI

```
# Merge BLOCK GROUP shape file with ADI
adi_nola$fips = as.numeric(adi_nola$FIPS)
adi_nola$adi_strnk = as.numeric(adi_nola$ADI_STATERNK)
mapdata_adi_n = left_join(orleans_bg, adi_nola, by="fips")

# Map the data
map_adi_n = ggplot(data=mapdata_adi_n) + geom_sf(aes(fill = adi_strnk), size=0.005, color="white") +
  scale_fill_distiller(palette = "RdYlBu", name="ADI State Rank")
```

Map New Orleans COI

```
# Merge census tract shape file with COI
mapdata_coi_n = left_join(orleans_ct, coi_nola, by="fips") %>%
          mutate(risk_cat_n = recode(c5_COI_stt,
                                     "Very High" = 5,
                                     "High" = 4,
                                     "Moderate" = 3,
                                     "Low" = 2,
                                     "Very Low" = 1 ))

# Map the data
map_coi_nola <- ggplot(data = mapdata_coi_n) + geom_sf(aes(fill = risk_cat_n), size=0.005, color="white
          scale_fill_distiller(palette = "RdYlBu", trans="reverse", limits = c(5,1))
map_coi_nola + map_theme + guides(fill=guide_legend(title="COI Category", reverse=TRUE))
```



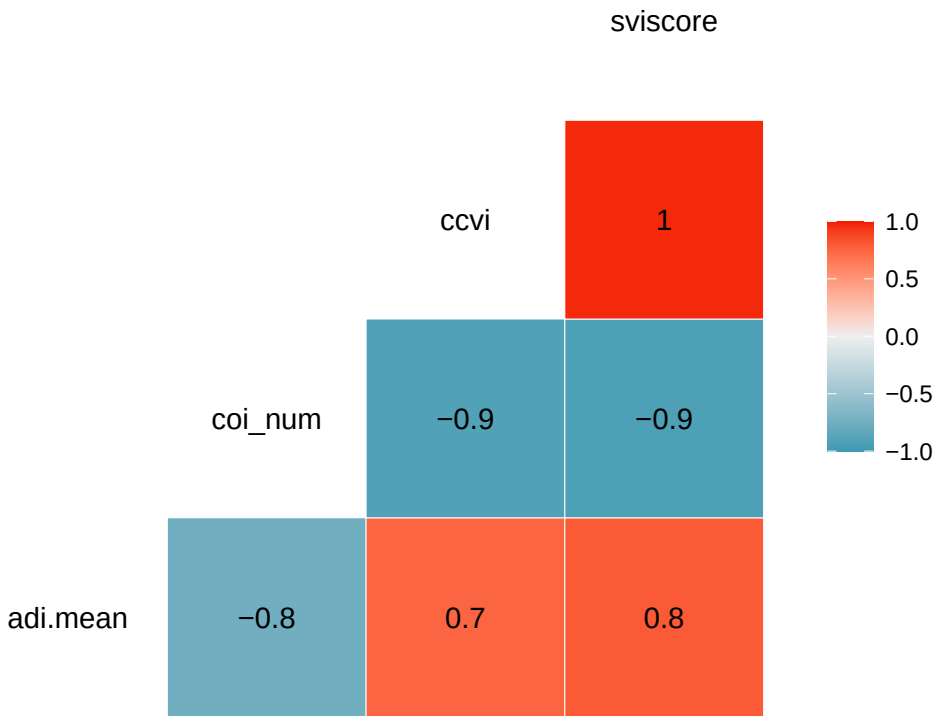
Durham Correlation Plot

```
# Concatenate State, County, and Census Tract into single variable
durham_19ct_totalpop <-
  tidyr::separate(
```

```
    data = durham_19ct_totalpop,
    col = GEOID,
    sep = c(7),
    into = c("ante", "FIPS_CT"),
    remove = FALSE
  ) %>%
  rename(total = ALUBE001) %>% #rename total population variable
  mutate(FIPS_CT = substring(FIPS_CT, first = 1, last = 11)) #Create census tract GEOIDs by truncating

#Subset if ADI is NA
adi_durham_na <-subset(adi_durham, ADI_STATERNK != "")

#Merge truncated ADI dataset with census tract dataset that has Total Population
adi_totalpop_durham = merge(durham_19ct_totalpop, adi_durham, by.x ="FIPS_CT", by.y = "FIPS")
adi_totalpop_durham_na <-subset(adi_totalpop_durham, ADI_STATERNK != "")

#Loop over each census tract GEOID and calculate weighted median, mean and unweighted median, mean
adi_totalpop_durham_stats <- foreach(x = unique(adi_totalpop_durham$FIPS_CT), .combine = "rbind", .packa

  #Create a temporary subset with block groups from the xth census tract
  temp <- adi_totalpop_durham[adi_totalpop_durham$FIPS_CT == x , ]

  #If there is at least 1 block group in the xth census tract . .
  if(nrow(temp) > 0) {

    #Calculate the weight for each block group as the proportion of the total pop in the xth census tra
    temp$weights <- temp$Total / sum(temp$Total)

    #Create a dataframe with the xth census tract GEOID and each of the desired metrics
    summary.out <- data.frame(
      FIPS_CT = x,
      adi.median = weighted.median(
        temp$ADI_STATERNK, temp$weights),
      adi.mean = weighted.mean(x = temp$ADI_STATERNK, w = temp$weights),
      adi.median.uw = median(temp$ADI_STATERNK),
      adi.mean.uw = mean(temp$ADI_STATERNK)
    )

    #Return the median dataframe
    return(summary.out)
  }
}
```

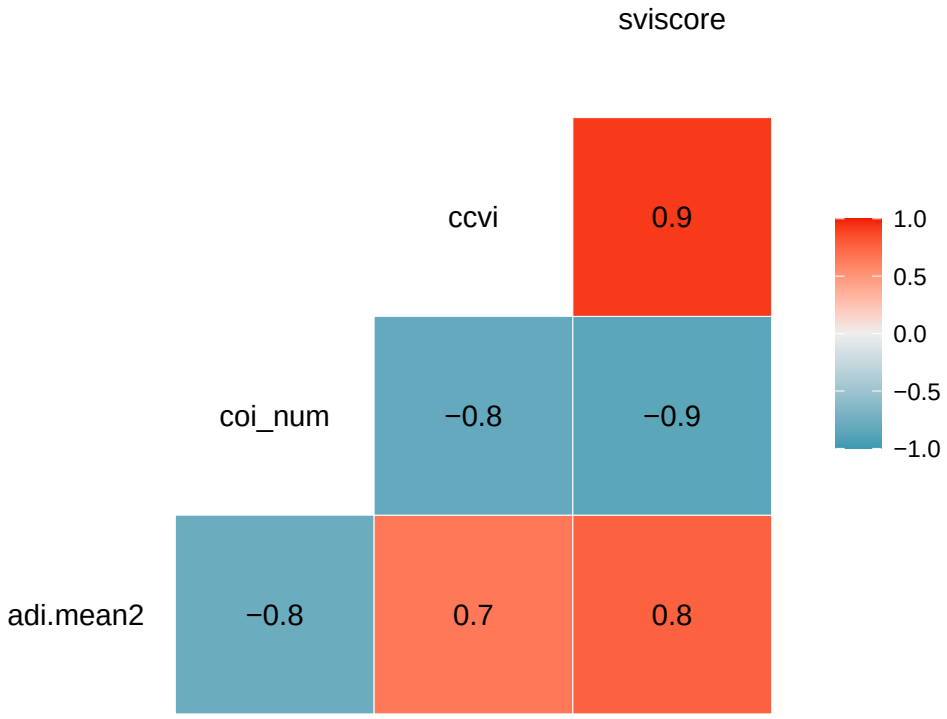
```
# Convert COI to numeric value
all_durham$coi_num = dplyr::recode(all_durham$c5_COI_stt,
                            "Very High" = 5,
                            "High" = 4,
                            "Moderate" = 3,
                            "Low" = 2,
                            "Very Low" = 1)

# Keep weighted mean ADI (adi.mean), COI (c5_COI_stt), ccvi (ccvi), SVI (sviscore)
durham_justindices <- all_durham %>%
 select(c("adi.mean", "coi_num", "ccvi", "sviscore")) %>%
```

```
  filter(adi.mean != "")

# Create plot
ggcorr(durham_justindices, method = c("pairwise", "spearman"),
       nbreaks = NULL, digits = 2, low = "#3B9AB2",
       mid = "#EEEEEE", high = "#F21A00",
       geom = "tile", label = TRUE,
       label_alpha = FALSE)
```



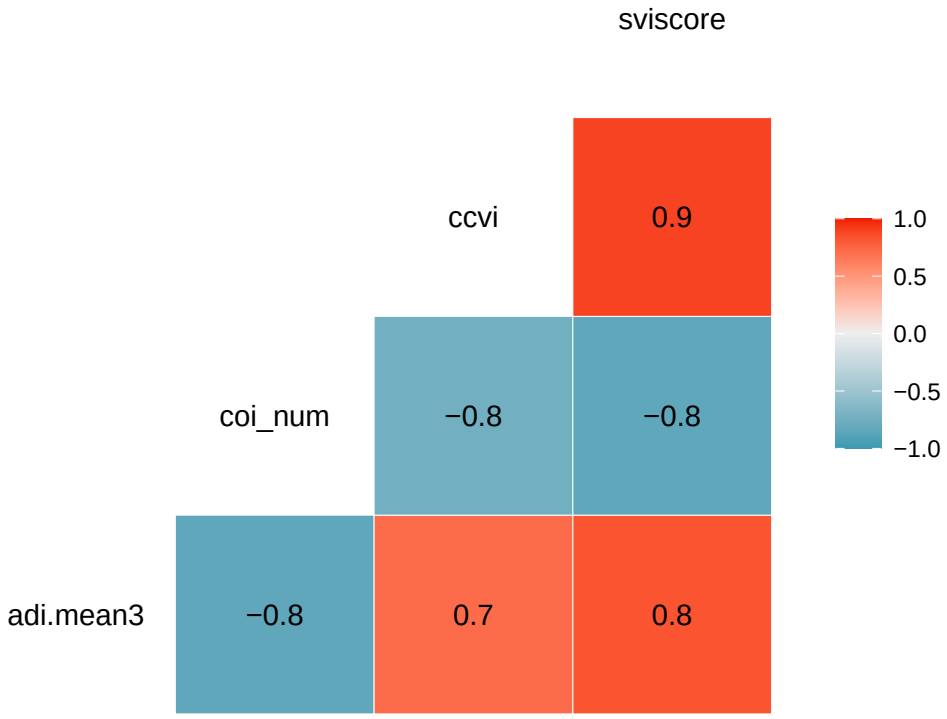
Chicago Correlation Plot

```
all_cookcounty$coi_num = recode(all_cookcounty$c5_COI_stt,
                            "Very High" = 5,
                            "High" = 4,
                            "Moderate" = 3,
                            "Low" = 2,
                            "Very Low" = 1)

cookcounty_justindices <- all_cookcounty[ ,c("adi.mean2", "coi_num", "ccvi", "sviscore")]
cookcounty_justindices2 <-subset(cookcounty_justindices, adi.mean2 != "")

write.csv(all_cookcounty, file="all_cookcounty.csv")

# Create plot
ggcorr(cookcounty_justindices2, method = c("pairwise", "spearman"),
       nbreaks = NULL, digits = 2, low = "#3B9AB2",
       mid = "#EEEEEE", high = "#F21A00",
       geom = "tile", label = TRUE,
       label_alpha = FALSE)
```



New Orleans Correlation Plot

```
all_nola$coi_num = recode(all_nola$c5_COI_stt,
                          "Very High" = 5,
                          "High" = 4,
                          "Moderate" = 3,
                          "Low" = 2,
                          "Very Low" = 1)
# Keep weighted mean ADI (adi.mean), COI (c5_COI_stt), ccvi (ccvi), SVI (sviscore)
nola_justindices <- all_nola[ ,c("adi.mean3", "coi_num", "ccvi", "sviscore")]
nola_justindices2 <-subset(nola_justindices, adi.mean3 != "" & ccvi!="" & coi_num!="" & sviscore!="")

# Create plot
ggcorr(nola_justindices2, method = c("pairwise", "spearman"),
       nbreaks = NULL, digits = 2, low = "#3B9AB2",
       mid = "#EEEEEE", high = "#F21A00",
       geom = "tile", label = TRUE,
       label_alpha = FALSE)
```



Durham Moran's I

```
all_durham <- all_durham %>%
  drop_na("adi.mean") %>%
  drop_na("coi_num") %>%
  drop_na("ccvi") %>%
  drop_na("sviscore")

# Merge index data with census tract data
all_durham$fips <- as.numeric(all_durham$fips)
data_merged_durham <- inner_join(durham_tracts, all_durham, by = "fips")

# Identify neighboring polygons
nb = poly2nb(data_merged_durham, queen=TRUE)

# Assign weights to neighbors
lw_d = nb2listw(nb, style="W", zero.policy=TRUE)

# Durham ADI
moran(data_merged_durham$adi.mean, lw_d, length(nb), Szero(lw_d), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.4360367
##
## $K
## [1] 2.492436
```

```
moran.test(data_merged_durham$adi.mean, lw_d, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_durham$adi.mean
## weights: lw_d
```

```
##
## Moran I statistic standard deviate = 5.7863, p-value = 3.598e-09
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       0.436036703      -0.017857143       0.006153347
```

```
# Durham COI
moran(data_merged_durham$coi_num, lw_d, length(nb), Szero(lw_d), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.3235709
##
## $K
## [1] 1.524653
```

```
moran.test(data_merged_durham$coi_num, lw_d, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_durham$coi_num
## weights: lw_d
##
## Moran I statistic standard deviate = 4.3134, p-value = 8.039e-06
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       0.323570861      -0.017857143       0.006265651
```

```
# Durham CCVI
moran(data_merged_durham$ccvi, lw_d, length(nb), Szero(lw_d), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.2535108
##
## $K
## [1] 1.805737
```

```
moran.test(data_merged_durham$ccvi, lw_d, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_durham$ccvi
## weights: lw_d
##
## Moran I statistic standard deviate = 3.4372, p-value = 0.0002938
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       0.253510781      -0.017857143       0.006233033
```

```
# Durham SVI
moran(data_merged_durham$sviscore, lw_d, length(nb), Szero(lw_d), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.2941997
```

```
##
## $K
## [1] 1.555554
```

```
moran.test(data_merged_durham$sviscore, lw_d, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_durham$sviscore
## weights: lw_d
##
## Moran I statistic standard deviate = 3.9434, p-value = 4.016e-05
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       0.294199688      -0.017857143       0.006262065
```

Chicago Moran's I

```
all_cookcounty <- all_cookcounty %>%
  drop_na("adi.mean2") %>% select(-"fips.y", -"FIPS.y") %>%
  drop_na("coi_num") %>%
  drop_na("ccvi") %>%
  drop_na("sviscore")

# Merge index data with census tract data
cookcounty_ct$fips_ch = as.character(cookcounty_ct$GEOID)
all_cookcounty$fips_ch = as.character(all_cookcounty$fips)
data_merged_chi <- inner_join(cookcounty_ct, all_cookcounty , by="fips_ch", all.y=TRUE) %>% drop_na("adi

## Identify neighboring polygons
nb_c = poly2nb(data_merged_chi, queen=TRUE)

## Assign weights to neighbors
lw_c = nb2listw(nb_c, style="W", zero.policy=TRUE)

# Chicago ADI
moran(data_merged_chi$adi.mean2, lw_c, length(nb_c), Szero(lw_c), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.7967689
##
## $K
## [1] 2.132155
```

```
moran.test(data_merged_chi$adi.mean2, lw_c, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_chi$adi.mean2
## weights: lw_c
##
## Moran I statistic standard deviate = 50.915, p-value < 2.2e-16
```

```
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##      0.7967689302     -0.0007656968      0.0002453644
```

```
# Chicago COI
moran(data_merged_chi$coi_num, lw_c, length(nb_c), Szero(lw_c), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.7900334
##
## $K
## [1] 1.714718
```

```
moran.test(data_merged_chi$coi_num, lw_c, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_chi$coi_num
## weights: lw_c
##
## Moran I statistic standard deviate = 50.477, p-value < 2.2e-16
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##      0.7900333960     -0.0007656968      0.0002454430
```

```
# Chicago CCVI
moran(data_merged_chi$ccvi, lw_c, length(nb_c), Szero(lw_c), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.6699439
##
## $K
## [1] 2.064676
```

```
moran.test(data_merged_chi$ccvi, lw_c, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_chi$ccvi
## weights: lw_c
##
## Moran I statistic standard deviate = 42.817, p-value < 2.2e-16
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##      0.6699438771     -0.0007656968      0.0002453771
```

```
# Chicago SVI
moran(data_merged_chi$sviscore, lw_c, length(nb_c), Szero(lw_c), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.6875493
##
## $K
```

```
## [1] 1.76071
```

```
moran.test(data_merged_chi$sviscore, lw_c, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_chi$sviscore
## weights: lw_c
##
## Moran I statistic standard deviate = 43.936, p-value < 2.2e-16
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##      0.6875492993     -0.0007656968      0.0002454344
```

New Orleans Moran's I

```
all_nola <- all_nola %>%
  drop_na("adi.mean3") %>% select(-"fips.y", -"FIPS.y") %>%
  drop_na("coi_num") %>%
  drop_na("ccvi") %>%
  drop_na("sviscore")

orleans_ct$fips_n = as.character(orleans_ct$GEOID)
all_nola$fips_n = as.character(all_nola$fips)
data_merged_n <- inner_join(orleans_ct, all_nola, by = "fips_n", all.y=TRUE) %>% drop_na("adi.mean3")

## Identify neighboring polygons
nb_n = poly2nb(data_merged_n, queen=TRUE)

## Assign weights to neighbors
lw_n = nb2listw(nb_n, style="W", zero.policy=TRUE)

# NOLA ADI
moran(data_merged_n$adi.mean3, lw_n, length(nb_n), Szero(lw_n), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.5929999
##
## $K
## [1] 1.766624
```

```
moran.test(data_merged_n$adi.mean3, lw_n, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_n$adi.mean3
## weights: lw_n
##
## Moran I statistic standard deviate = 13.024, p-value < 2.2e-16
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
```

```
##       0.592999909      -0.005952381       0.002114910
```

```
# NOLA COI
moran(data_merged_n$coi_num, lw_n, length(nb_n), Szero(lw_n), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.5451424
##
## $K
## [1] 1.391957
```

```
moran.test(data_merged_n$coi_num, lw_n, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_n$coi_num
## weights: lw_n
##
## Moran I statistic standard deviate = 11.97, p-value < 2.2e-16
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       0.545142399      -0.005952381       0.002119697
```

```
# NOLA CCVI
moran(data_merged_n$ccvi, lw_n, length(nb_n), Szero(lw_n), zero.policy=TRUE, NAOK=TRUE)
```

```
## $I
## [1] 0.4788105
##
## $K
## [1] 2.416052
```

```
moran.test(data_merged_n$ccvi, lw_n, na.action=na.omit, zero.policy=TRUE)
```

```
##
##  Moran I test under randomisation
##
## data:  data_merged_n$ccvi
## weights: lw_n
##
## Moran I statistic standard deviate = 10.562, p-value < 2.2e-16
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       0.478810543      -0.005952381       0.002106612
```

```
# NOLA SVI
moran(data_merged_n$sviscore, lw_n, length(nb_n), Szero(lw_n), zero.policy=TRUE, NAOK=TRUE)
```

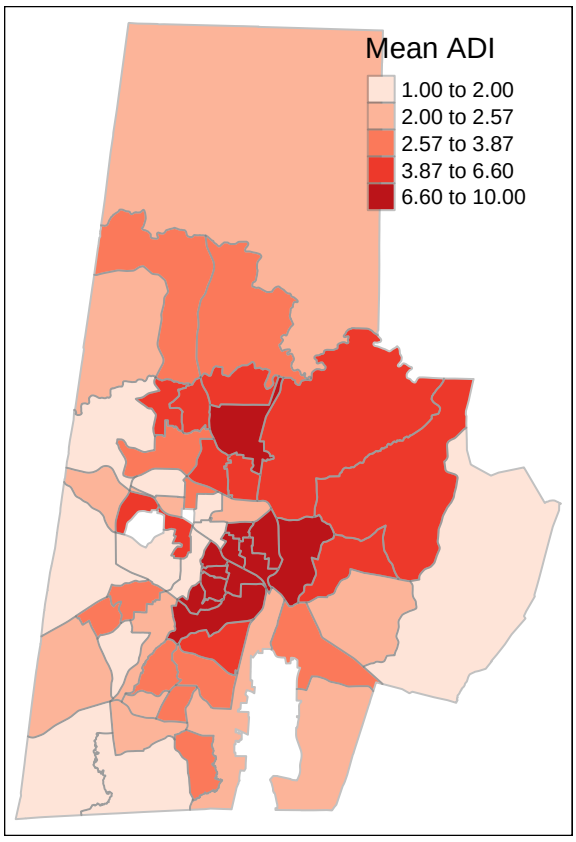
```
## $I
## [1] 0.5138274
##
## $K
## [1] 1.781028
```

```
moran.test(data_merged_n$sviscore, lw_n, na.action=na.omit, zero.policy=TRUE)
```

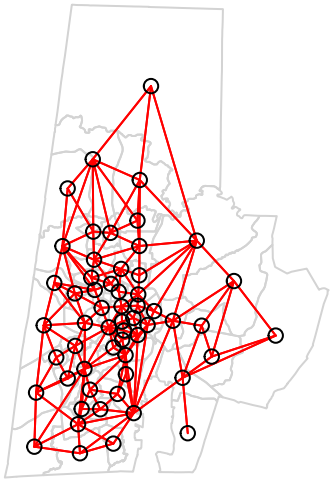
```
##
##  Moran I test under randomisation
##
## data:  data_merged_n$sviscore
## weights: lw_n
##
## Moran I statistic standard deviate = 11.303, p-value < 2.2e-16
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       0.513827414      -0.005952381       0.002114726
```

Plot Durham Moran's I

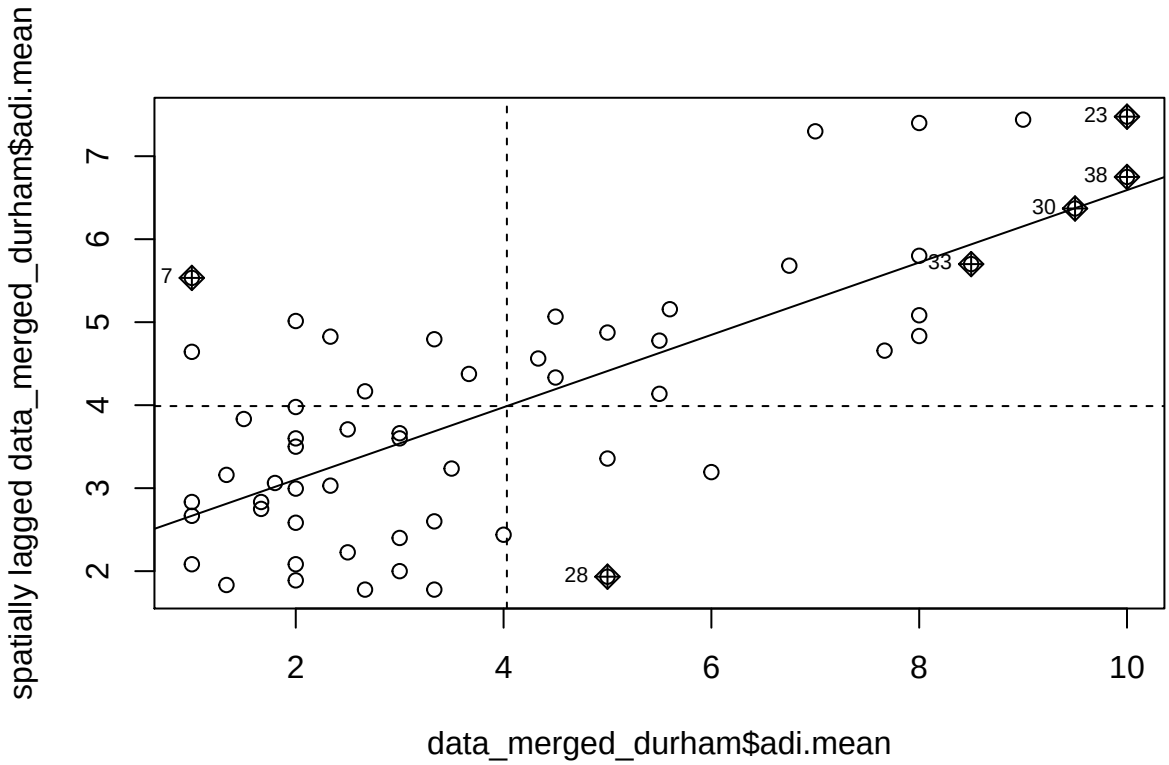
```
options(prompt="R> ", digits=4, scipen=999)

# Transform merged Durham ADI and tract file into a shape file
data_merged_shape = st_as_sf(data_merged_durham)

# Map Durham ADI
tm_shape(data_merged_shape) +
  tm_fill("adi.mean",
          palette = "Reds",
          style = "quantile",
          title = "Mean ADI") +
  tm_borders(alpha=.4)
```



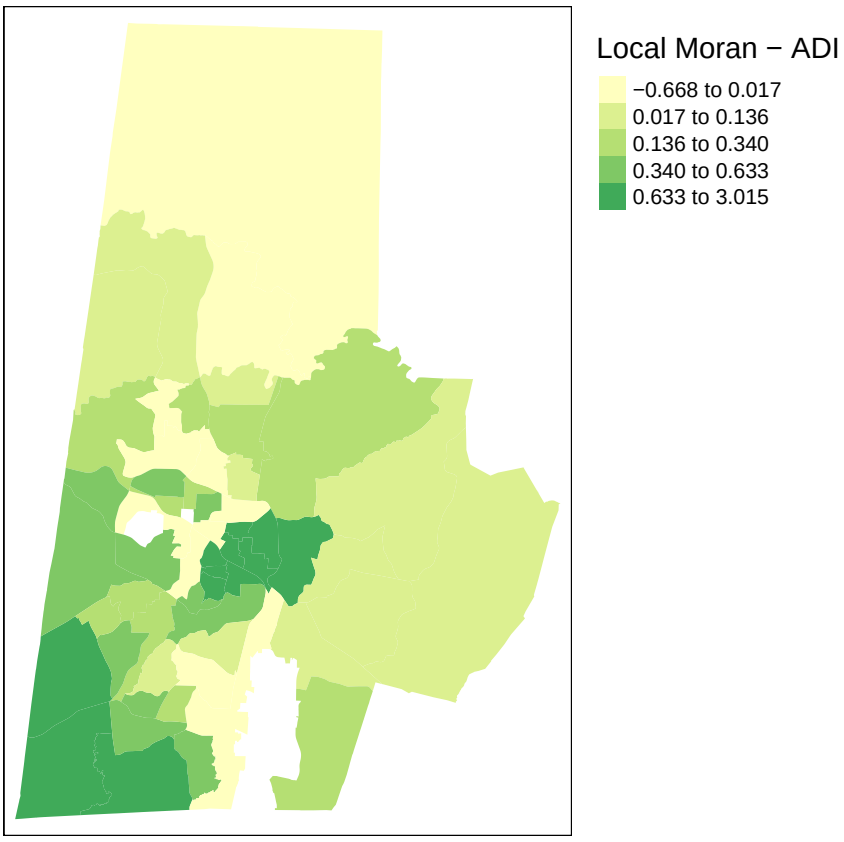

```
# Find queen neighbors
nb_durham = poly2nb(data_merged_durham)
nb_durham_sf = poly2nb(data_merged_shape)

# Plot queen neighbors
plot(st_geometry(data_merged_durham), border='lightgrey')
plot(nb_durham, st_coordinates(st_centroid(data_merged_durham)), add=TRUE, col='red')
```



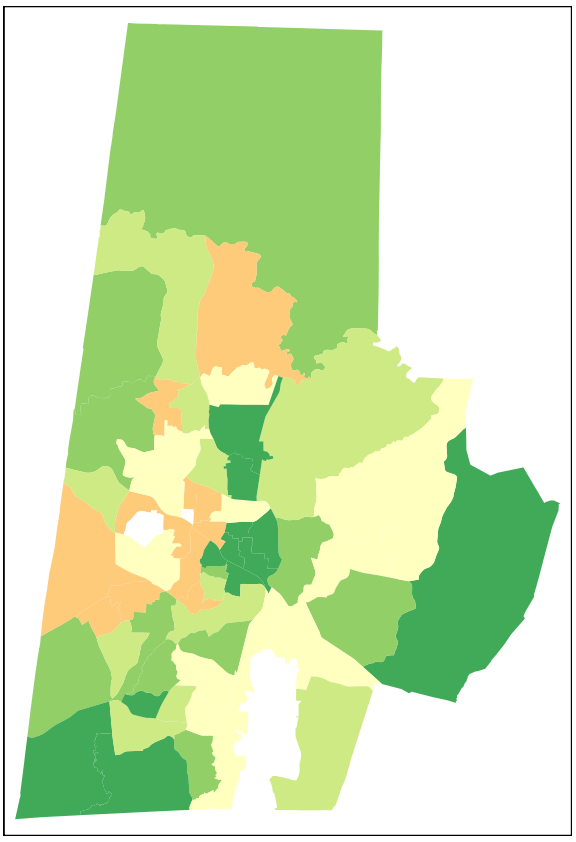
```
# Plot Moran map
moran=moran.plot(data_merged_durham$adi.mean, listw = nb2listw(nb_durham, style = "W"))
```



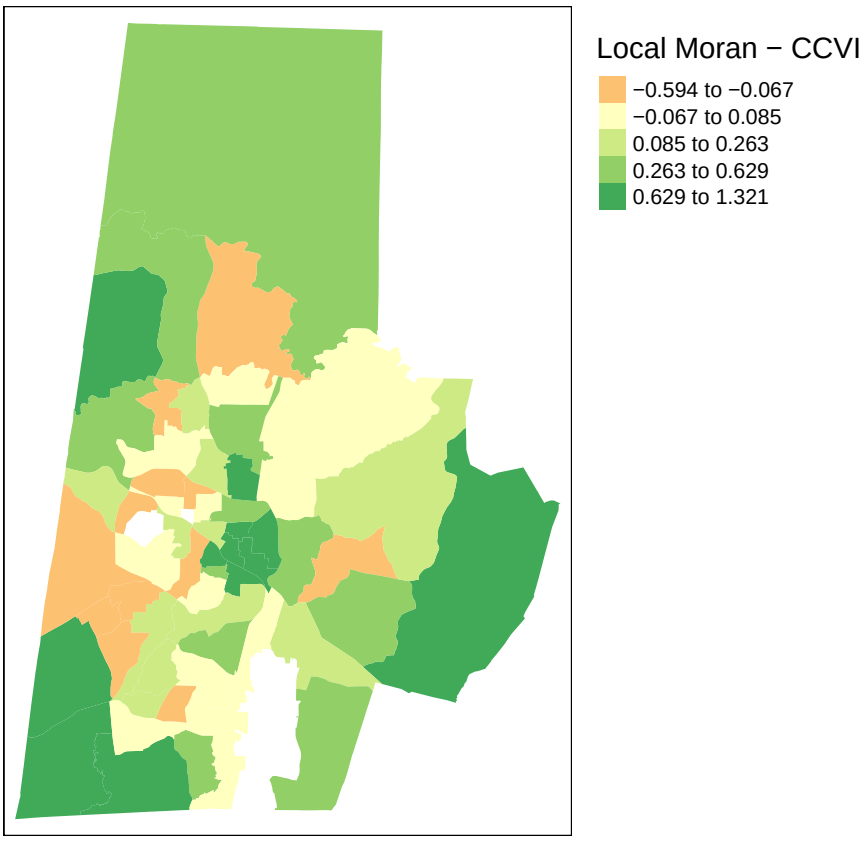

```
# Local Moran
local = localmoran(x=data_merged_durham $adi.mean, listw = nb2listw(nb_durham, style = "W"))
local_d_svi = localmoran(x=data_merged_durham$sviscore, listw = nb2listw(nb_durham, style = "W"))
local_d_ccvi = localmoran(x=data_merged_durham$ccvi, listw = nb2listw(nb_durham, style = "W"))
local_d_coi = localmoran(x=data_merged_durham$coi_num, listw = nb2listw(nb_durham, style = "W"))


# Plot clustering
  # ADI
moran.map_durham = cbind(data_merged_durham, local)
tm_shape(moran.map_durham) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - ADI") +
          tm_layout(legend.outside = TRUE)
```



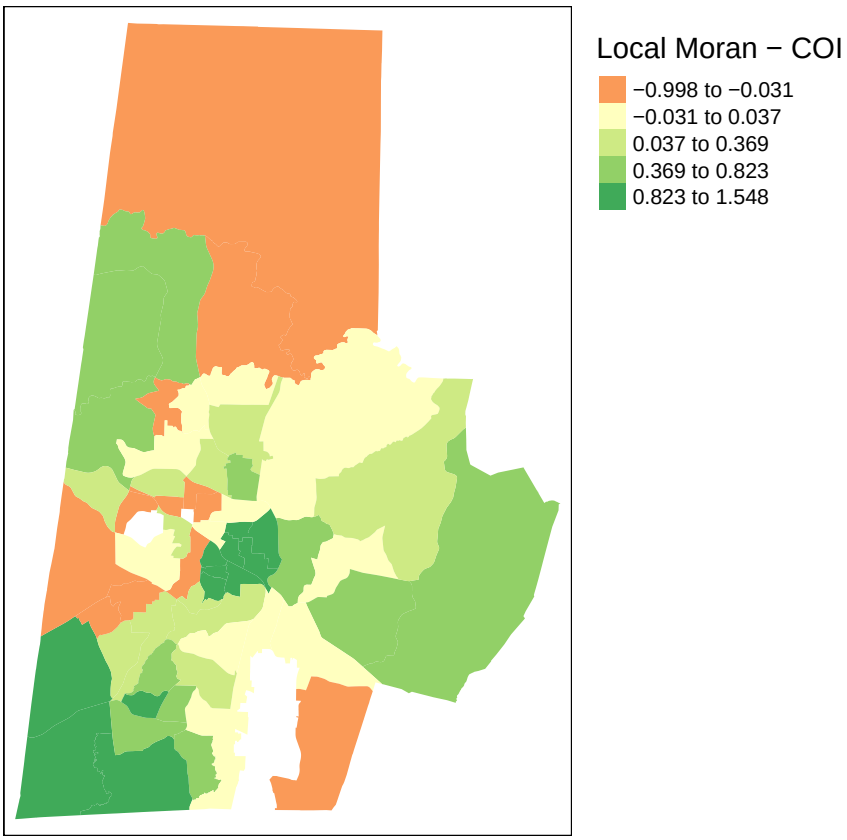

```
  # SVI
moran.map_durham = cbind(data_merged_durham, local_d_svi)
tm_shape(moran.map_durham) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - SVI") +
          tm_layout(legend.outside = TRUE)
```




```
  # CCVI
moran.map_durham = cbind(data_merged_durham, local_d_ccvi)
tm_shape(moran.map_durham) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - CCVI") +
          tm_layout(legend.outside = TRUE)
```

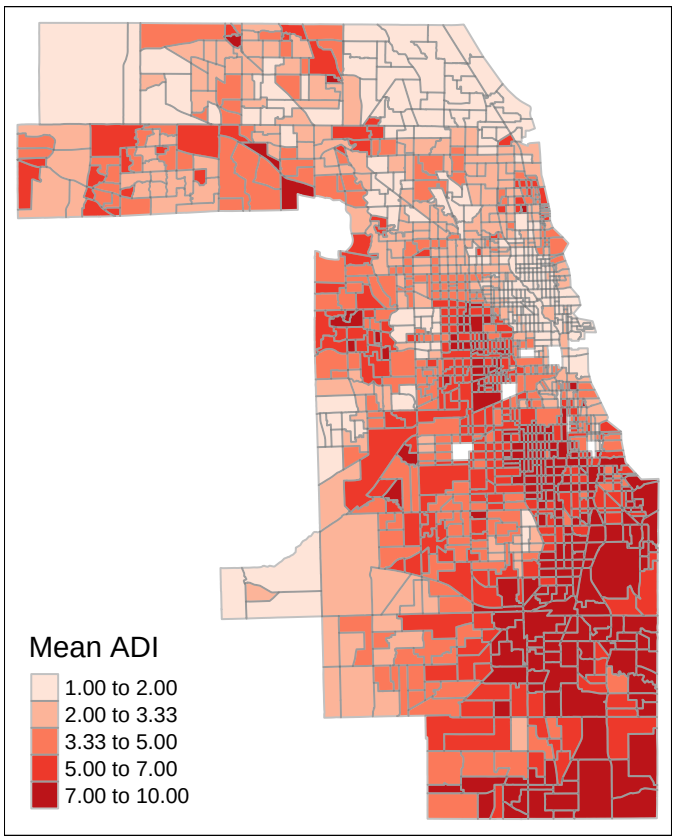



```
  # COI
moran.map_durham = cbind(data_merged_durham, local_d_coi)
tm_shape(moran.map_durham) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - COI") +
          tm_layout(legend.outside = TRUE)
```

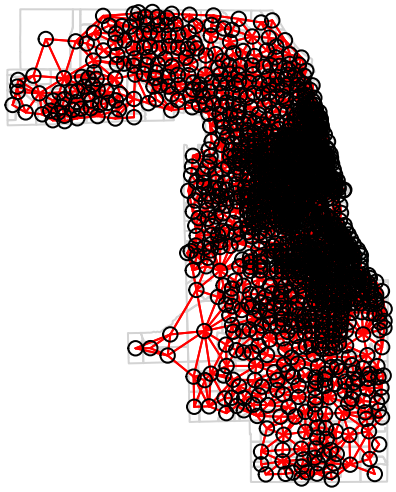


Plot Chicago Moran's I

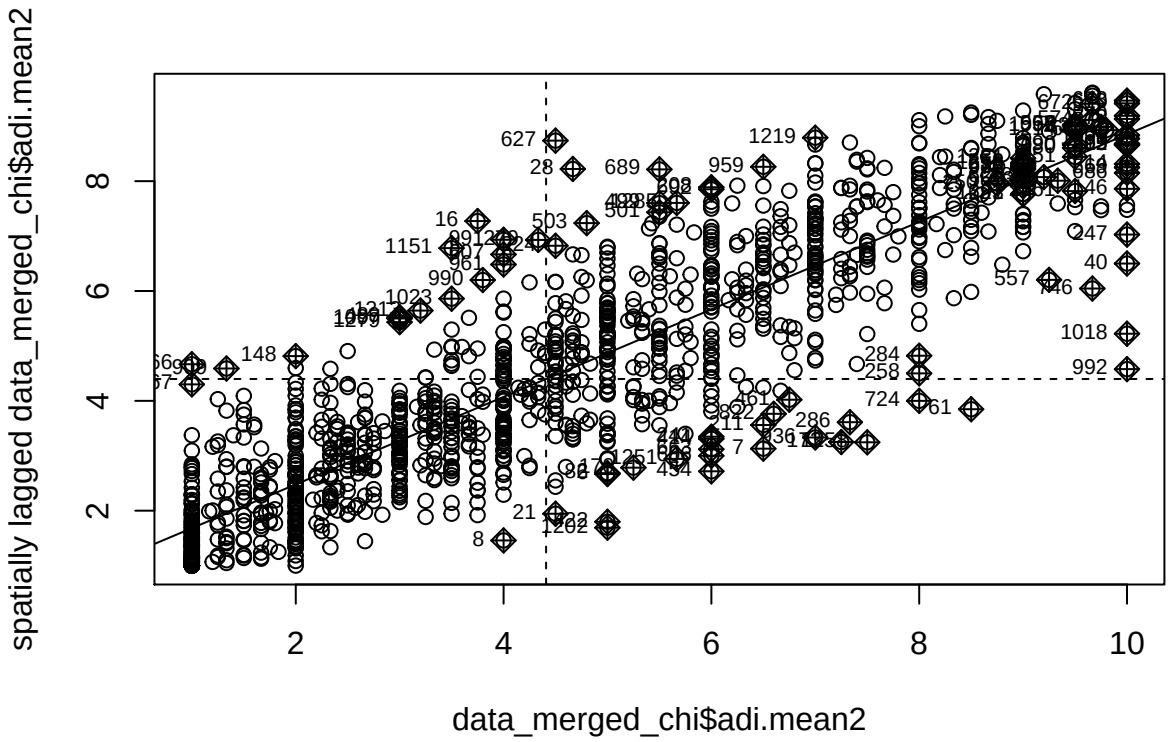
```
# Transform merged CHICAGO ADI and tract file into a shape file
data_merged_chi_sf = st_as_sf(data_merged_chi)


# Map Chicago ADI
tm_shape(data_merged_chi_sf) +
  tm_fill("adi.mean2",
          palette = "Reds",
          style = "quantile",
          title = "Mean ADI") +
  tm_borders(alpha=.4)
```



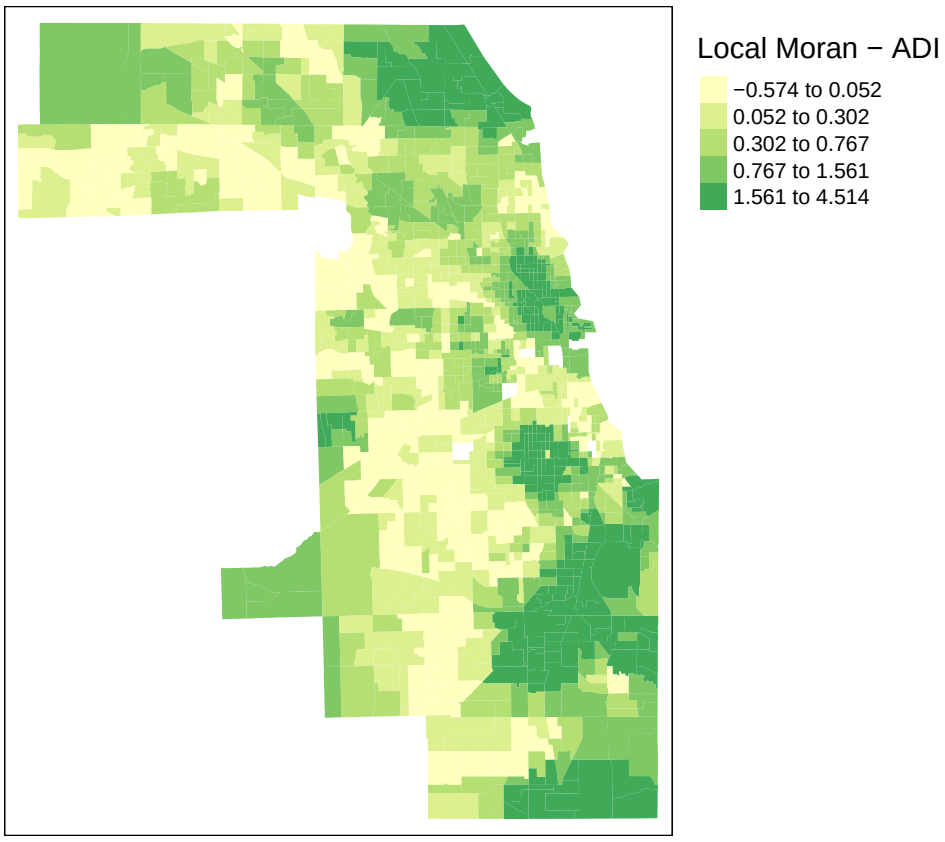

```
# Find queen neighbors
nb_cook = poly2nb(data_merged_chi)
nb_cook_sf = poly2nb(data_merged_chi_sf)

# Plot queen neighbors
plot(st_geometry(data_merged_chi), border='lightgrey')
plot(nb_cook, st_coordinates(st_centroid(data_merged_chi)), add=TRUE, col='red')
```



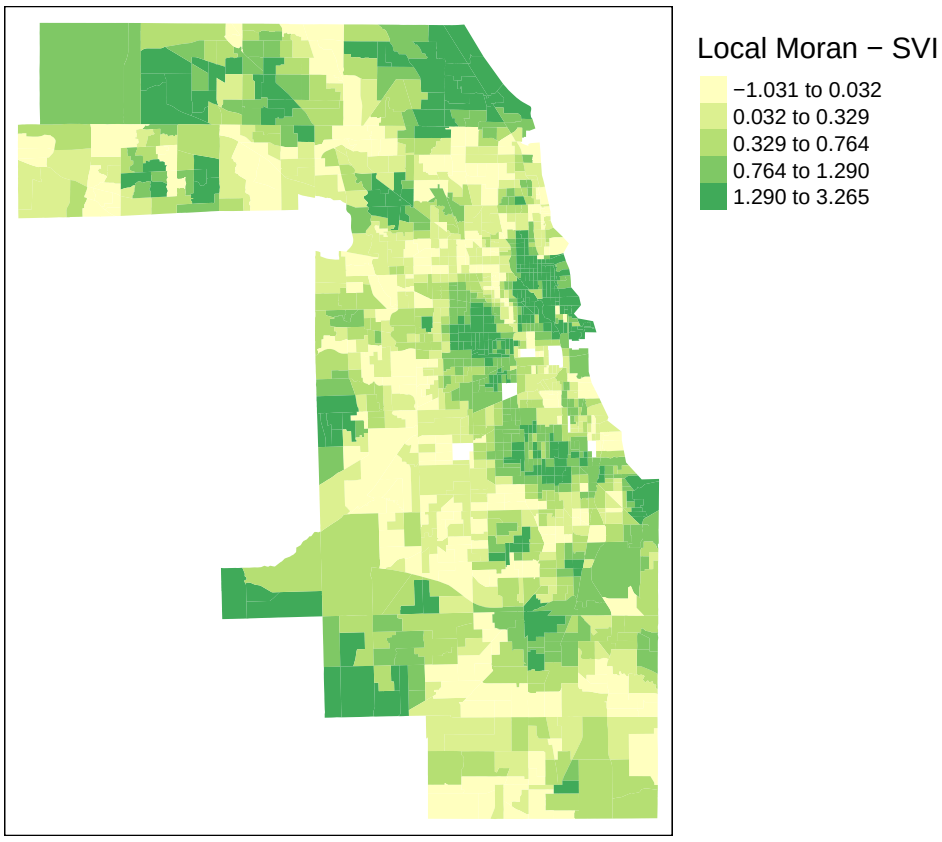
```
# Plot Moran map
moran_c=moran.plot(data_merged_chi$adi.mean2, listw = nb2listw(nb_cook, style = "W", zero.policy=TRUE))
```



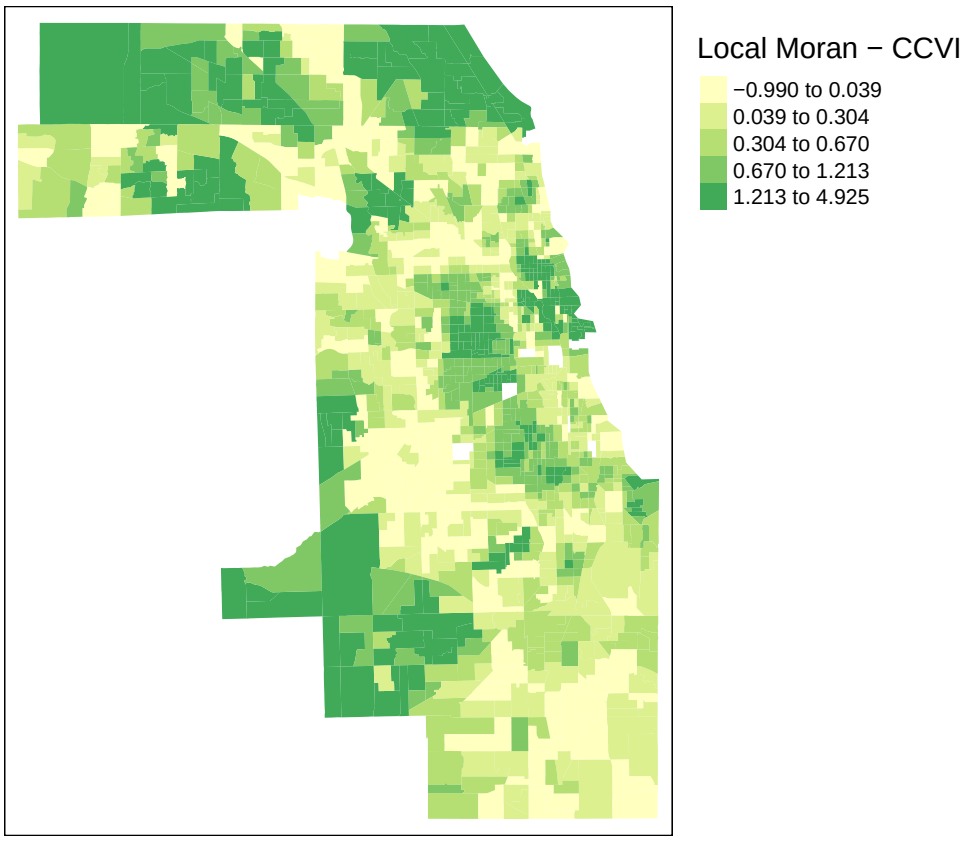

```
# Local Moran
local_c_adi  =  localmoran(x=data_merged_chi$adi.mean2, listw = nb2listw(nb_cook, style = "W", zero.poli
local_c_svi  =  localmoran(x=data_merged_chi$sviscore, listw = nb2listw(nb_cook, style = "W"))
local_c_ccvi =  localmoran(x=data_merged_chi$ccvi, listw = nb2listw(nb_cook, style = "W"))
local_c_coi  =  localmoran(x=data_merged_chi$coi_num, listw = nb2listw(nb_cook, style = "W"))


# Plot clustering
# ADI
moran.map_chicago = cbind(data_merged_chi, local_c_adi)
tm_shape(moran.map_chicago) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - ADI") +
          tm_layout(legend.outside = TRUE)
```



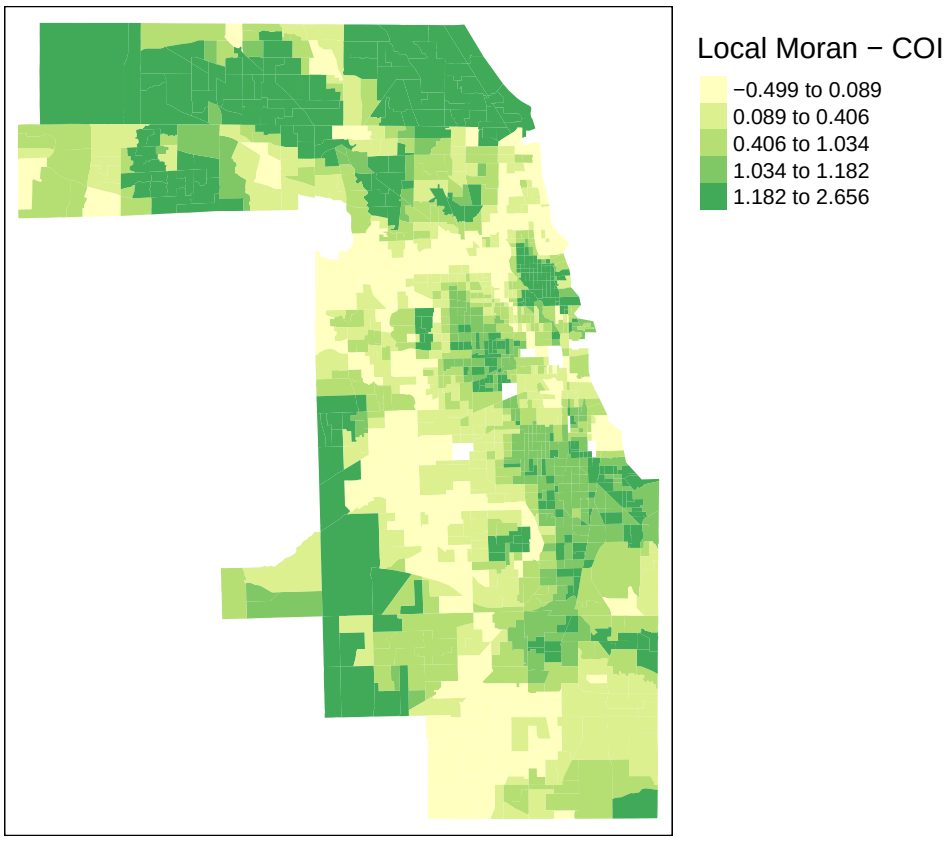

```
# SVI
moran.map_chicago = cbind(data_merged_chi, local_c_svi)
tm_shape(moran.map_chicago) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - SVI") +
          tm_layout(legend.outside = TRUE)
```




```
# CCVI
moran.map_chicago = cbind(data_merged_chi, local_c_ccvi)
tm_shape(moran.map_chicago) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - CCVI") +
          tm_layout(legend.outside = TRUE)
```

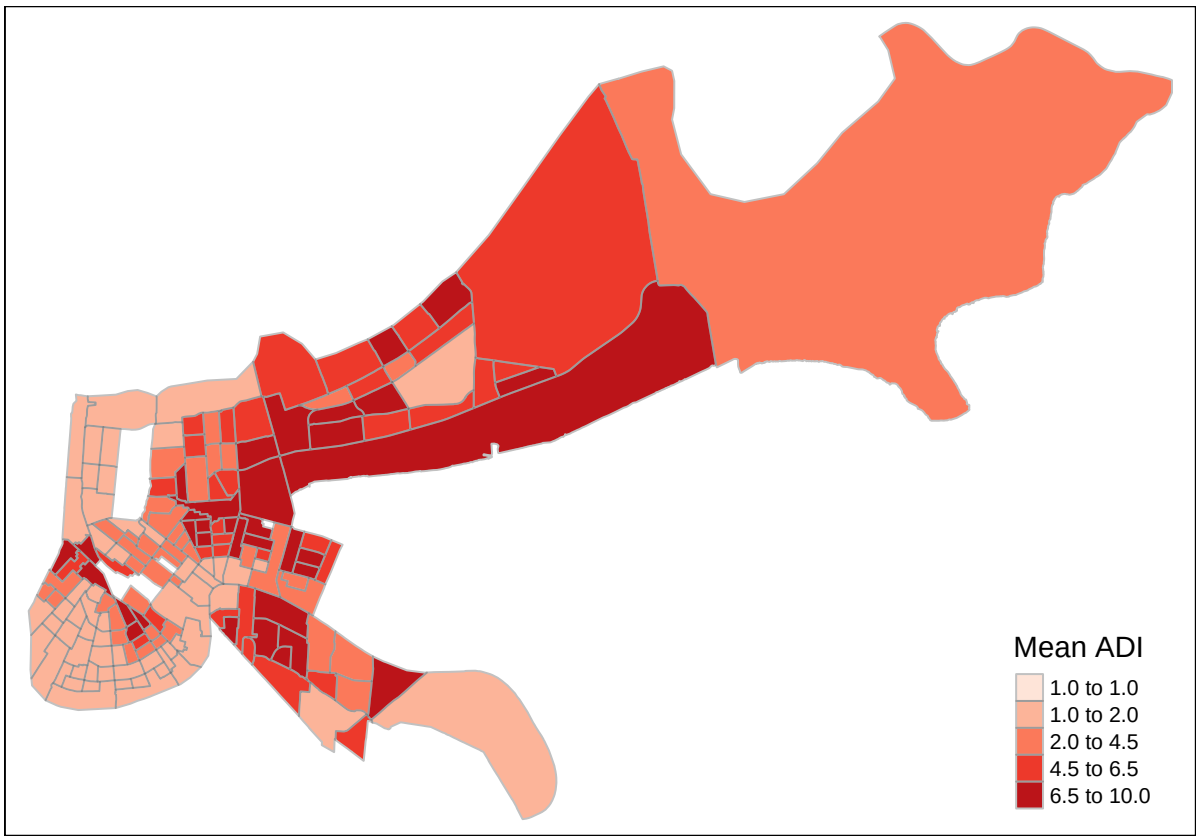



```
# COI
moran.map_chicago = cbind(data_merged_chi, local_c_coi)
tm_shape(moran.map_chicago) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - COI") +
          tm_layout(legend.outside = TRUE)
```

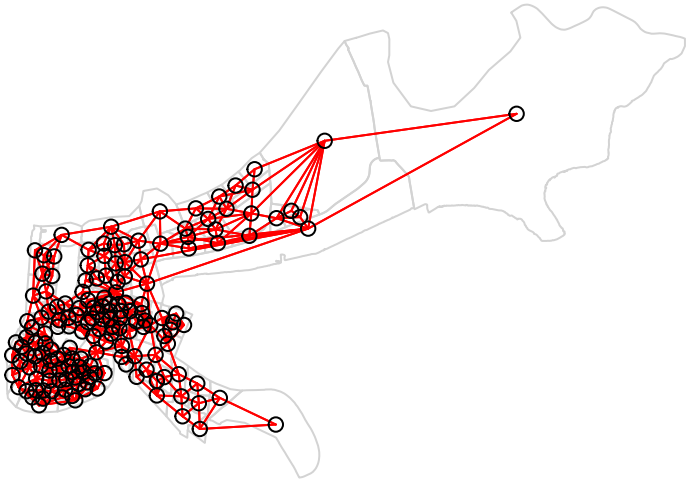


Plot New Orleans Moran's I

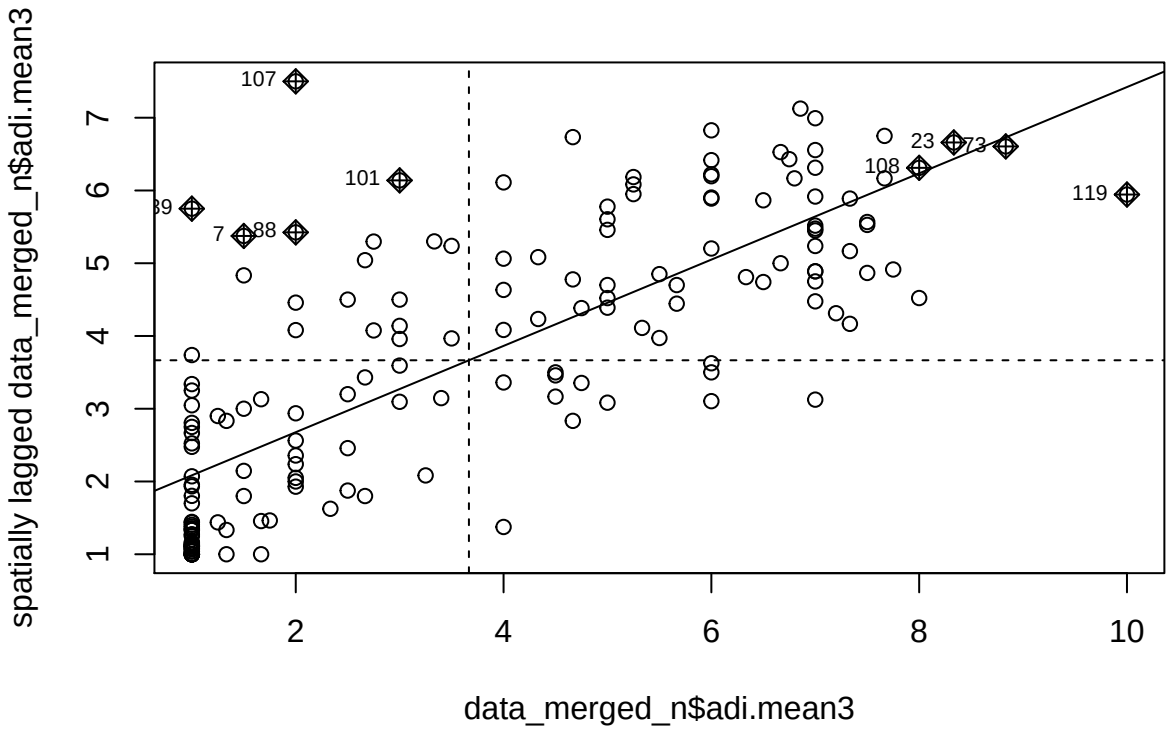
```
data_merged_n_sf = st_as_sf(data_merged_n)
tm_shape(data_merged_n_sf) +
  tm_fill("adi.mean3",
          palette = "Reds",
          style = "quantile",
          title = "Mean ADI") +
  tm_borders(alpha=.4)
```



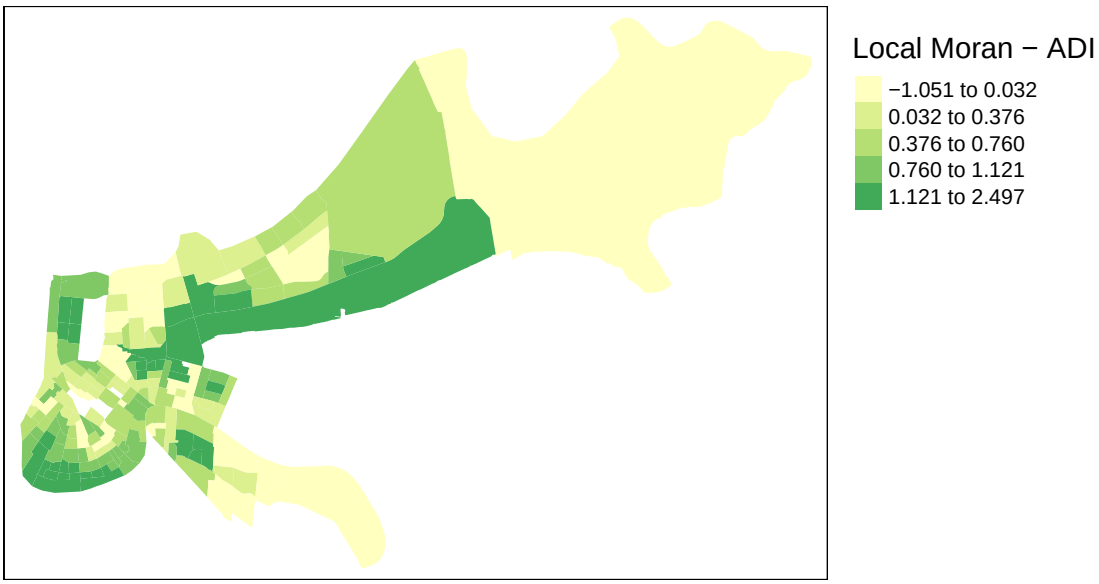

```
# Find queen neighbors
nb_orleans = poly2nb(data_merged_n)
nb_orleans_sf = poly2nb(data_merged_n_sf)

# Plot queen neighbors
plot(st_geometry(data_merged_n), border='lightgrey')
plot(nb_orleans, st_coordinates(st_centroid(data_merged_n)), add=TRUE, col='red')
```



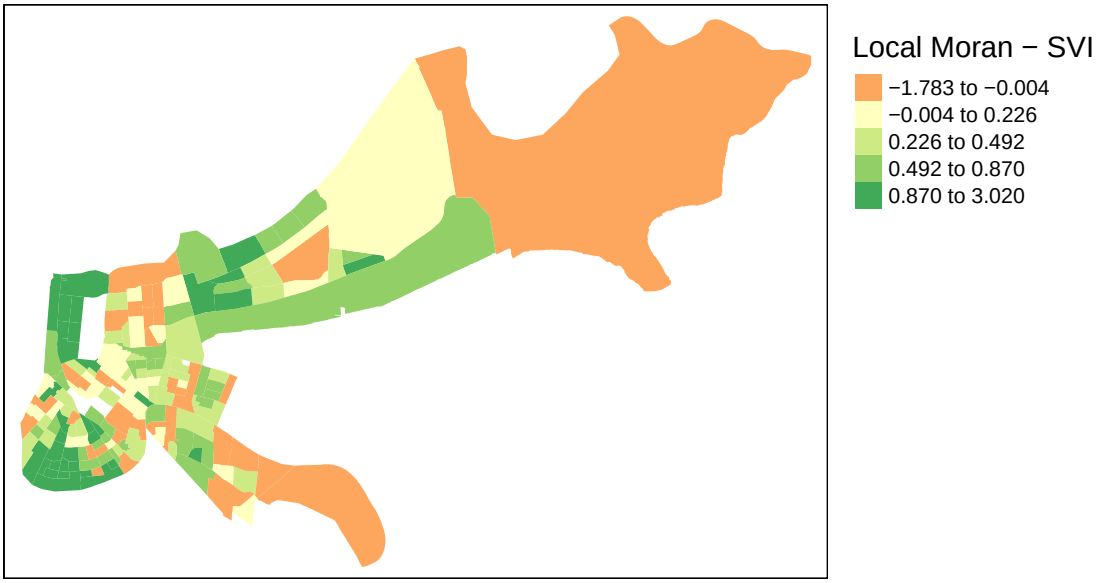
```
# Plot Moran map
moran_n=moran.plot(data_merged_n$adi.mean3, listw = nb2listw(nb_orleans, style = "W", zero.policy=TRUE)
```



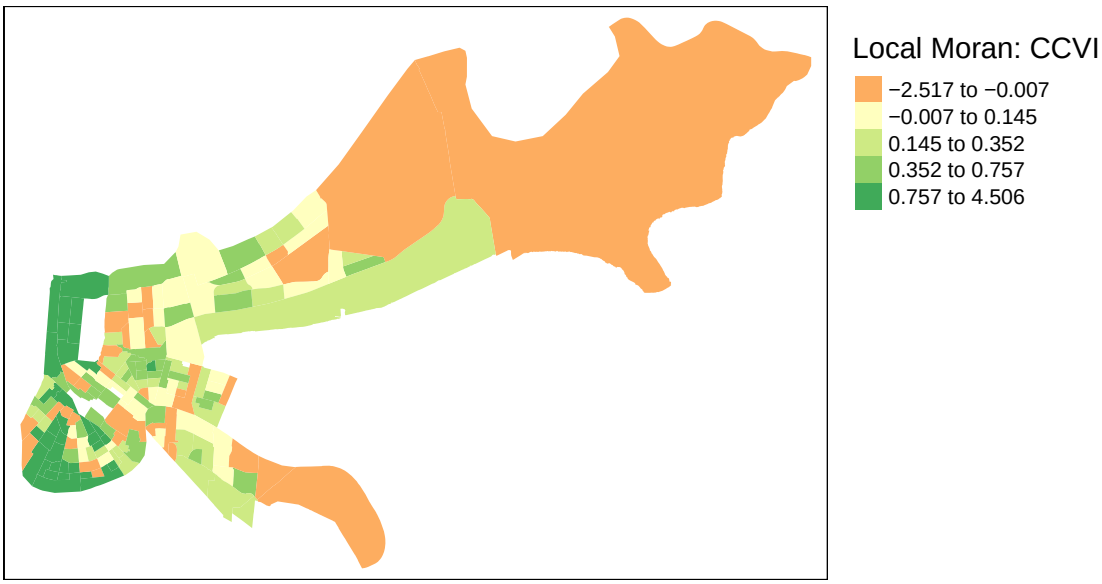

```
# Local Moran
local_n_adi  =  localmoran(x=data_merged_n$adi.mean3, listw = nb2listw(nb_orleans, style = "W", zero.po
local_n_svi  =  localmoran(x=data_merged_n$sviscore, listw = nb2listw(nb_orleans, style = "W"))
local_n_ccvi =  localmoran(x=data_merged_n$ccvi, listw = nb2listw(nb_orleans, style = "W"))
local_n_coi  =  localmoran(x=data_merged_n$coi_num, listw = nb2listw(nb_orleans, style = "W"))


# Plot clustering
# ADI
moran.map_orleans = cbind(data_merged_n, local_n_adi)
tm_shape(moran.map_orleans) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - ADI") +
          tm_layout(legend.outside = TRUE)
```




```
# SVI
moran.map_orleans = cbind(data_merged_n, local_n_svi)
tm_shape(moran.map_orleans) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran - SVI") +
          tm_layout(legend.outside = TRUE)
```




```
# CCVI
moran.map_orleans = cbind(data_merged_n, local_n_ccvi)
tm_shape(moran.map_orleans) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran: CCVI") +
          tm_layout(legend.outside = TRUE)
```




```
# COI
moran.map_orleans = cbind(data_merged_n, local_n_coi)
tm_shape(moran.map_orleans) +
  tm_fill(col = "Ii",
          style = "quantile",
          title = "Local Moran: COI") +
          tm_layout(legend.outside = TRUE)
```