PBL Draft

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Library Downloads

```
library(tidyverse)
library(sf)
library(units)
library(readr)
library(tmap)
library(viridis)
library(dplyr)
library(stringr)

library(tidycensus)
library(tigris)
options(tigris_use_cache = TRUE)
CRS.new <- st_crs("EPSG:3435")
```

We are limiting this analysis to the year 2025. No way to actually filter CTA Rail data before download.

Data Retrieval

```
crimes_raw <- st_read("crimes_2025.csv")
```

```
## Reading layer `crimes_2025' from data source
##   `C:\Users\enigh\OneDrive\Desktop\SOSC 13220\Final Project\crimes_2025.csv'
##   using driver `CSV'
```

```
## Warning: no simple feature geometries present: returning a data.frame or tbl_df
```

```
cta_rail_stations <- st_read("cta_rail_stations.csv")
```

```
## Reading layer `cta_rail_stations' from data source
##   `C:\Users\enigh\OneDrive\Desktop\SOSC 13220\Final Project\cta_rail_stations.csv'
##   using driver `CSV'
```

```
## Warning: no simple feature geometries present: returning a data.frame or tbl_df
```

```
police_station_raw <- st_read("police_stations.csv")
```

```
## Reading layer ‘police_stations’ from data source
##   ‘C:\Users\enigh\OneDrive\Desktop\SOSC 13220\Final Project\police_stations.csv’
##   using driver ‘CSV’

## Warning: no simple feature geometries present: returning a data.frame or tbl_df
```

```
cta_ridership_raw <- st_read("cta_rail_ridership.csv")
```

```
## Reading layer ‘cta_rail_ridership’ from data source
##   ‘C:\Users\enigh\OneDrive\Desktop\SOSC 13220\Final Project\cta_rail_ridership.csv’
##   using driver ‘CSV’

## Warning: no simple feature geometries present: returning a data.frame or tbl_df
```

Load in polygon dataset:

```
com_areas <- st_read("comm_area.geojson")
```

```
## Reading layer ‘comm_area’ from data source
##   ‘C:\Users\enigh\OneDrive\Desktop\SOSC 13220\Final Project\comm_area.geojson’
##   using driver ‘GeoJSON’
## Simple feature collection with 77 features and 9 fields
## Geometry type: MULTIPOLYGON
## Dimension:     XY
## Bounding box:  xmin: -87.94011 ymin: 41.64454 xmax: -87.52414 ymax: 42.02304
## Geodetic CRS:  WGS 84
```

Data Cleaning/Wrangling

We need to filter CTA ridership data to just the year 2025. We also need to aggregate data, as ridership is currently broken down into months.

```
cta_ridership_clean <- cta_ridership_raw %>%
  mutate(YEAR = as.integer(YEAR)) %>%
  filter(YEAR == 2025)

cta_ridership_clean <- cta_ridership_clean %>%
  mutate(TOTAL_RIDES = as.numeric(TOTAL_RIDES)) %>%  # ensure numeric
  group_by(RIDERSHIP_ID, NAME) %>%
  summarise(
    total_rides_2025 = sum(TOTAL_RIDES, na.rm = TRUE),
    .groups = "drop"
  ) %>%
  arrange(desc(total_rides_2025))

head(cta_ridership_clean)
```

```
## # A tibble: 6 x 3
##   RIDERSHIP_ID NAME           total_rides_2025
##   <chr>        <chr>                     <dbl>
## 1 1660         Lake/State              3212890
## 2 890          O’Hare Airport          3005653
## 3 380          Clark/Lake              2798412
## 4 1220         Fullerton               2370481
## 5 1450         Chicago/State           2363911
## 6 260          State/Lake              2337971
```

```r
head(crimes_raw)
```

```
##         ID Case.Number                   Date                 Block IUCR
## 1 14120097    JK160527 01/01/2026 12:00:00 AM 030XX W FRANKLIN BLVD 0810
## 2 14118983    JK159390 01/01/2026 12:00:00 AM  053XX S MICHIGAN AVE 1305
## 3 14112519    JK151612 01/01/2026 12:00:00 AM   102XX S EMERALD AVE 1565
## 4 14103838    JK140954 01/01/2026 12:00:00 AM   064XX S STEWART AVE 0810
## 5 14100237    JK136833 01/01/2026 12:00:00 AM       042XX W 31ST ST 0486
## 6 14096413    JK131515 01/01/2026 12:00:00 AM  006XX N LOCKWOOD AVE 1130
##         Primary.Type                      Description Location.Description
## 1              THEFT                        OVER $500            APARTMENT
## 2    CRIMINAL DAMAGE              CRIMINAL DEFACEMENT      OTHER (SPECIFY)
## 3        SEX OFFENSE INDECENT SOLICITATION OF A CHILD            RESIDENCE
## 4              THEFT                        OVER $500            APARTMENT
## 5            BATTERY          DOMESTIC BATTERY SIMPLE            RESIDENCE
## 6 DECEPTIVE PRACTICE         FRAUD OR CONFIDENCE GAME            APARTMENT
##   Arrest Domestic Beat District Ward Community.Area FBI.Code X.Coordinate
## 1  false    false 1221      012   27             23       06
## 2  false    false 0225      002    3             40       14      1178064
## 3  false    false 2232      022   21             73       17      1173114
## 4  false     true 0722      007    6             68       06      1174731
## 5  false     true 1031      010   22             30      08B      1148654
## 6  false    false 1524      015   37             25       11      1140914
##   Y.Coordinate Year             Updated.On     Latitude     Longitude
## 1              2026 02/25/2026 03:43:24 PM
## 2      1869625 2026 02/25/2026 03:41:59 PM 41.797566426  -87.62254141
## 3      1837048 2026 02/18/2026 03:55:47 PM 41.708281913 -87.641654132
## 4      1862261 2026 02/09/2026 03:40:49 PM 41.777433807  -87.63498329
## 5      1883704 2026 02/05/2026 03:40:58 PM 41.836817925 -87.730030636
## 6      1903732 2026 02/05/2026 03:40:58 PM 41.891923124 -87.757939633
##                        Location
## 1
## 2  (41.797566426, -87.62254141)
## 3 (41.708281913, -87.641654132)
## 4  (41.777433807, -87.63498329)
## 5 (41.836817925, -87.730030636)
## 6 (41.891923124, -87.757939633)
```

We are also going to ignore crimes entries that have no location data (as otherwise, it is not possible to gauge whether it occurred within a buffer or not.) We also see that the datasets have latitude and longitude data but not point. We will convert to point data as well.

Crimes:

```
crimes_clean <- crimes_raw %>% select(-Location)

crimes_clean <- crimes_clean %>%
  mutate(Latitude = as.numeric(Latitude), Longitude = as.numeric(Longitude))

crimes_clean <- crimes_clean %>% filter(!is.na(Latitude) & !is.na(Longitude)) # we go from 236549 obser

crimes_sf <- crimes_clean %>%
  st_as_sf(coords = c("Longitude", "Latitude"), crs = 4326, remove = FALSE)
```

Ridership:

```
cta_rail_stations_sf <- cta_rail_stations %>%
  st_as_sf(wkt = "the_geom", crs = 4326)
```

Police stations:

```
police_station_clean <- police_station_raw %>% select(-LOCATION)

police_station_clean <- police_station_clean %>%
  mutate(LATITUDE = as.numeric(LATITUDE), LONGITUDE = as.numeric(LONGITUDE))

police_station_clean <- police_station_clean %>% filter(!is.na(LATITUDE) & !is.na(LONGITUDE)) # we go f

police_station_sf <- police_station_clean %>%
  st_as_sf(coords = c("LONGITUDE", "LATITUDE"), crs = 4326, remove = FALSE)
```

Transform to all use same CRS.

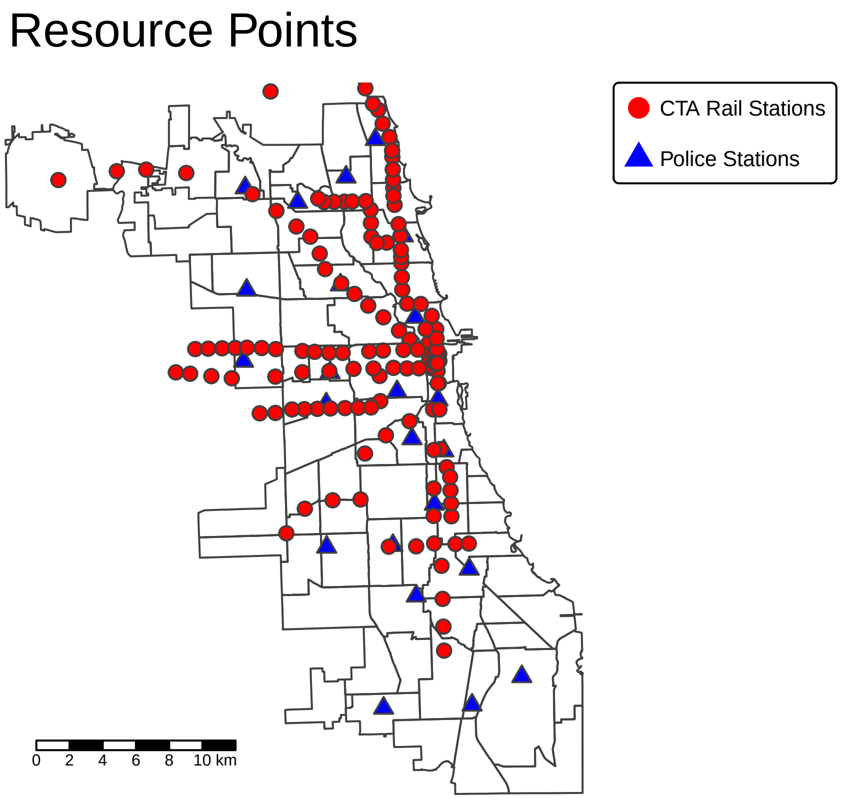
```
com_areas <- st_transform(com_areas, CRS.new)
crimes_sf <- st_transform(crimes_sf, CRS.new)
cta_rail_stations_sf <- st_transform(cta_rail_stations_sf, CRS.new)
police_station_sf <- st_transform(police_station_sf, CRS.new)
```

```
cta_rail_stations_sf <- cta_rail_stations_sf %>%
  left_join(cta_ridership_clean,
            by = c("STATION_ID" = "RIDERSHIP_ID"))
```

ESDA

First, plotting police stations + CTA rail stations.

```
tmap_mode("plot")

tm_shape(com_areas) + tm_borders() +
  tm_shape(police_station_sf) + tm_symbols(fill = "blue", shape = 24, size = 0.5) +
  tm_shape(cta_rail_stations_sf) + tm_symbols(fill = "red", size = 0.5) +
tm_layout(
    legend.outside = TRUE,
    legend.outside.position = "right",
    outer.margins = c(0.02, 0.02, 0.02, 0.18)) +
tm_layout(
    main.title = paste0("Resource Points"),
    main.title.size = 1.5,
    main.title.position = c("center", "top"),
    legend.outside = TRUE,
    bg.color = "white",
    frame = FALSE
  ) +
  tm_scalebar(position = c("left", "bottom"),
    text.size = 0.5 ) +
  tm_add_legend(
    type = "symbol",
    labels = "CTA Rail Stations",
    col = "red",
    shape = 16,
    size = 0.75
) +
  tm_add_legend(
    type = "symbol",
    labels = "Police Stations",
    col = "blue",
    shape = 17,
    size = 0.75
)
```



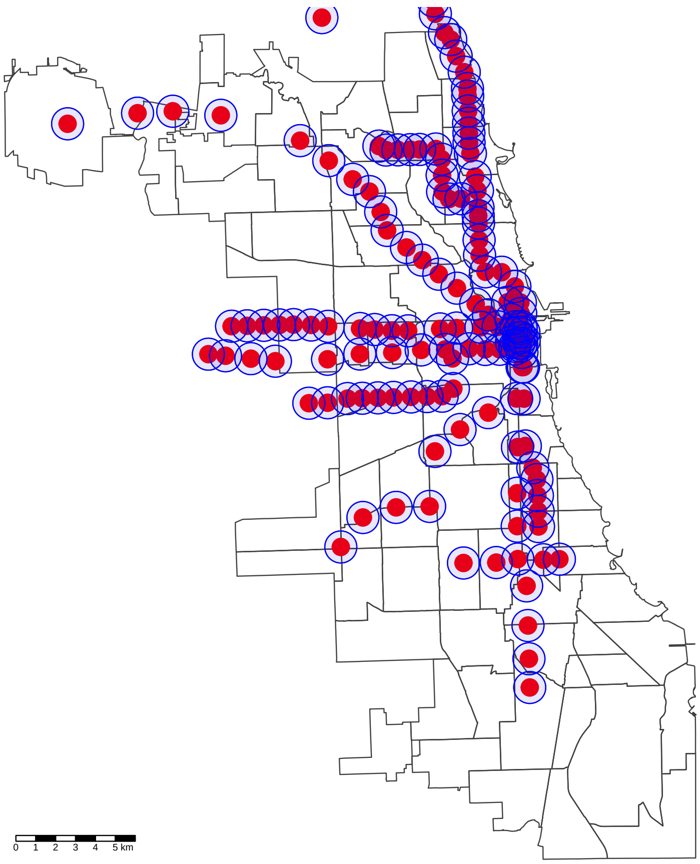
Buffers:

```
buffer_quarter_mi <- st_buffer(cta_rail_stations_sf, 0.25 * 5280)
buffer_quarter_mi <- st_transform(buffer_quarter_mi, CRS.new)

buffer_half_mi <- st_buffer(cta_rail_stations_sf, 0.5 * 5280)
buffer_half_mi <- st_transform(buffer_half_mi, CRS.new)

buffer_1_mi <- st_buffer(cta_rail_stations_sf, 5280)
buffer_1_mi <- st_transform(buffer_1_mi, CRS.new)
```

Buffer plots:

```
tmap_mode("plot")
tm_shape(com_areas) +
  tm_borders() +
  tm_shape(cta_rail_stations_sf) +
  tm_dots(fill="red", size=1) +
  tm_shape(buffer_half_mi) +
  tm_fill(col = "blue", alpha = 0.1) +
  tm_borders(col = "blue") +
  tm_layout(
    main.title = paste0("CTA Rail Stations: 0.25-mile Buffer"),
    main.title.size = 1.5,
    main.title.position = c("center", "top"),
    legend.outside = TRUE,
    bg.color = "white",
    frame = FALSE
  ) +
  tm_scalebar(position = c("left", "bottom"),
    text.size = 0.5 )
```

CTA Rail Stations: 0.25−mile Buffer



Note: Do we want to get rid of the CTA Rail stations that are part of the network but technically outside of Chicago?

Crime count in buffer:

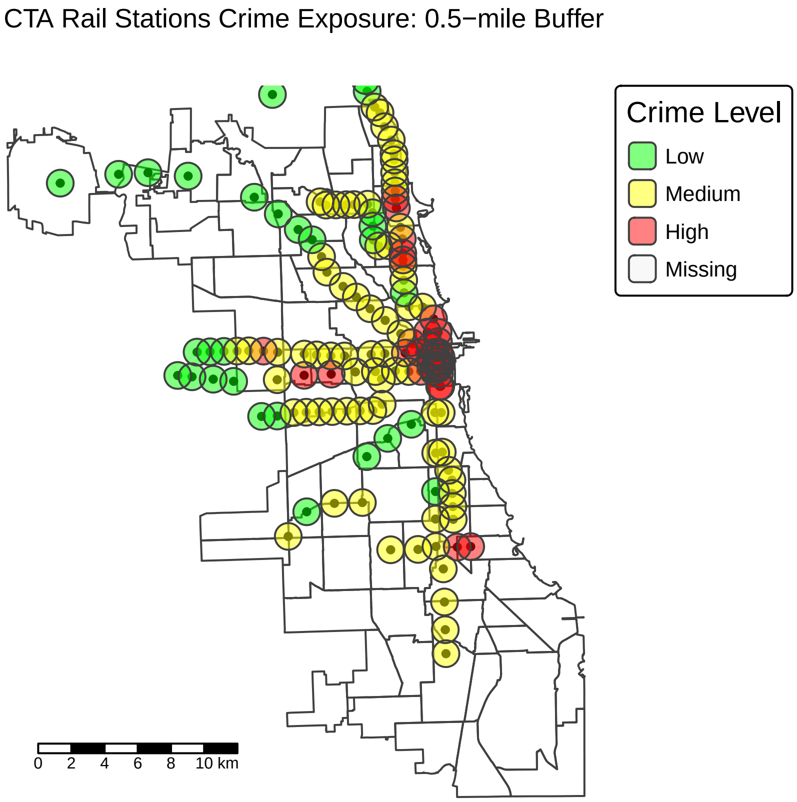
```r
crime_025_buffer <- lengths(st_intersects(buffer_quarter_mi, crimes_sf))
crime_05_buffer <- lengths(st_intersects(buffer_half_mi, crimes_sf))
crime_1_buffer <- lengths(st_intersects(buffer_1_mi, crimes_sf))

cta_rail_stations_sf$crime_count_025 <- crime_025_buffer
cta_rail_stations_sf$crime_count_05  <- crime_05_buffer
cta_rail_stations_sf$crime_count_1  <- crime_1_buffer

#IMPORTANT: overlapping buffers count crime twice
```

Crime Exposure Visualization:

```r
cta_rail_stations_sf <- cta_rail_stations_sf %>%
  mutate(
    crime_level_025 = case_when(
      crime_count_025 >= quantile(crime_count_025, 0.75, na.rm = TRUE) ~ "High",
      crime_count_025 >= quantile(crime_count_025, 0.25, na.rm = TRUE) ~ "Medium",
      TRUE ~ "Low"
    ),
    crime_level_025 = factor(crime_level_025, levels = c("Low", "Medium", "High"))
  )

exposure_025_buffer <- st_buffer(cta_rail_stations_sf, 0.25 * 5280)
```

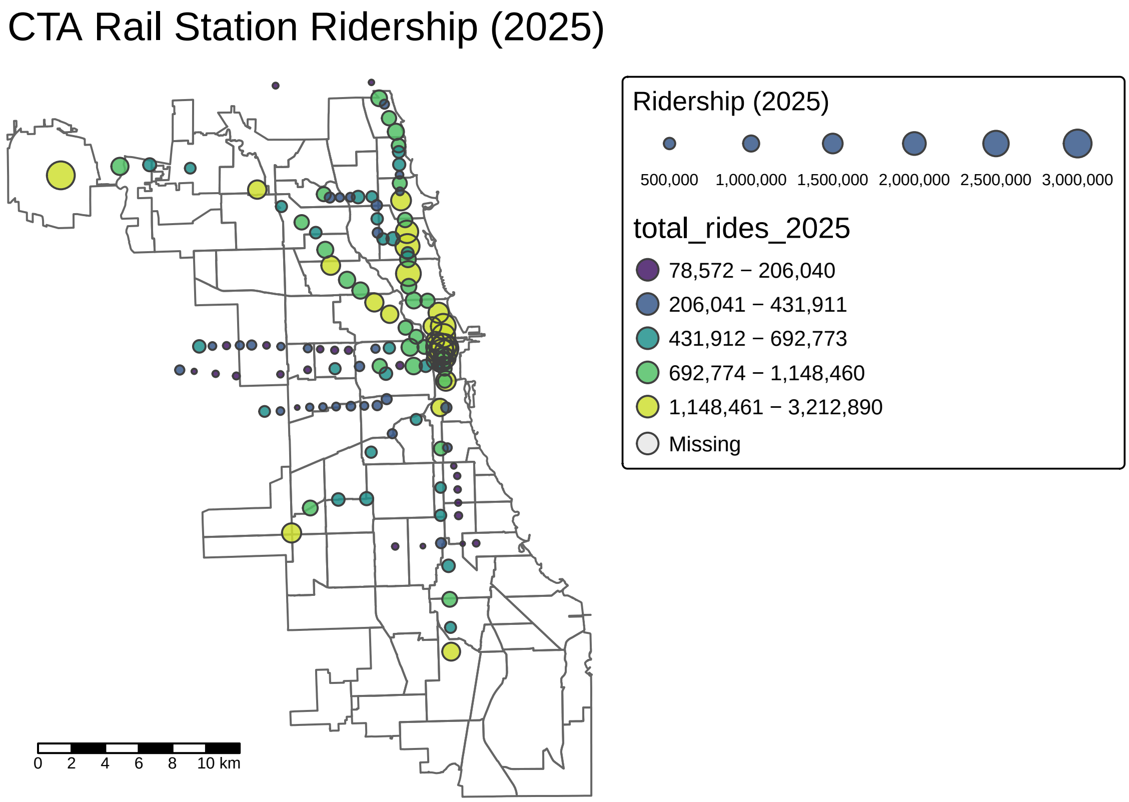
```r
cta_rail_stations_sf <- cta_rail_stations_sf %>%
  mutate(
    crime_level_05 = case_when(
      crime_count_05 >= quantile(crime_count_05, 0.75, na.rm = TRUE) ~ "High",
      crime_count_05 >= quantile(crime_count_05, 0.25, na.rm = TRUE) ~ "Medium",
      TRUE ~ "Low"
    ),
    crime_level_05 = factor(crime_level_05, levels = c("Low", "Medium", "High"))
  )

exposure_05_buffer <- st_buffer(cta_rail_stations_sf, 0.5 * 5280)
```

```r
tmap_mode("plot")
tm_shape(com_areas) +
  tm_borders() +
  tm_shape(cta_rail_stations_sf) +
  tm_dots(fill="black", size=0.25) +
  tm_shape(exposure_05_buffer) +
  tm_fill(
    col = "crime_level_05",
    palette = c("green", "yellow", "red"),
    title = "Crime Level",
    border.col = NA,
    alpha = 0.5
  ) +
  tm_layout(
    main.title = paste0("CTA Rail Stations Crime Exposure: 0.5-mile Buffer"),
    main.title.size = 1.5,
    main.title.position = c("center", "top"),
    legend.outside = TRUE,
    bg.color = "white",
    frame = FALSE
  ) +
  tm_scalebar(position = c("left", "bottom"),
    text.size = 0.5 )
```



Next, we want to go into ridership levels. Idea: also colorcode like above, with varying point colors.

```
tm_shape(com_areas) +
  tm_borders(col = "grey40") +
  tm_shape(cta_rail_stations_sf) +
  tm_symbols(
    size = "total_rides_2025",        # <-- change to your ridership column name if different
    col  = "total_rides_2025",        # optional: also color by ridership
    palette = "viridis",        # uses viridis-style palette name
    style = "quantile",         # good default for skewed ridership
    alpha = 0.85,
    title.size = "Ridership (2025)",
    title.col  = "Ridership (2025)"
  ) +
  tm_layout(
    main.title = "CTA Rail Station Ridership (2025)",
    legend.outside = TRUE,
    frame = FALSE
  ) +
  tm_scale_bar(position = c("left", "bottom"))
```


CTA Rail Station Ridership (2025)
Ridership (2025)
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
total_rides_2025
● 78,572 − 206,040
● 206,041 − 431,911
● 431,912 − 692,773
● 692,774 − 1,148,460
● 1,148,461 − 3,212,890
○ Missing
0
2
4
6
8
10 km