R_AS_GIS

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Contents

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Die Beispiel wurden vom Statistischen Amt des Kantons Zürich publiziert.

Die Portierung auf die RStudio-Umgebung wurde durch Peter Berger realisiert. Die ganzem Bereitstellung und Dokumentationsteile wurden aus Arbeiten von Timo Grossenbacher von SF Data übrnommen und adapiert.

Notes

This document was produced on Windows 10 with RStudio version 1.2.5001, the R "tidytext" package, the software "phantomjs-2.1.1-windows" which was placed on the C: drive and with adding the path the the PATH environment of Windows 10 and the "MiKTeX 2.9" software on Windows 10.

R-Script & processed data

I use Timo Grossenbacher's rddj-template as the basis for its R scripts. If you have problems executing this script, it may help to study the instructions from the rddj-template.

R-Script & data

The preprocessing and analysis of the data was conducted in the R project for statistical computing. The RMarkdown script used to generate this document and all the resulting data can be downloaded under this link. Through executing `main.Rmd`, the herein described process can be reproduced and this document can be generated. In the course of this, data from the folder `input` will be processed and results will be written to `output`.

GitHub

The code for the herein described process can also be freely downloaded from https://github.com/tgdbepe4/R_AS_GIS.

License

Disclaimer

The published information has been carefully compiled, but does not claim to be up-to-date, complete or correct. No liability is assumed for damages arising from the use of this script or the information drawn from it. This also applies to contents of third parties which are accessible via this offer. ...

Data description of output files

`abc.csv` (Example)

Attribute	Type	Description
a	Numeric	...
b	Numeric	...
c	Numeric	...

`xyz.csv`

...

Preparations

```
## Loading required package: knitr
```

```
## Loading required package: rstudioapi
```

```
## [1] "package package:rstudioapi detached"
```

```
## Warning: 'knitr' namespace cannot be unloaded:
##   namespace 'knitr' is imported by 'rmarkdown' so cannot be unloaded
```

```
## [1] "package package:knitr detached"
```

Define packages

```
# from https://mran.revolutionanalytics.com/web/packages/checkpoint/vignettes/using-checkpoint-with-kni
# if you don't need a package, remove it from here (commenting is probably not sufficient)
# tidyverse: see https://blog.rstudio.org/2016/09/15/tidyverse-1-0-0/
cat("
```

```
library(rstudioapi)
library(tidyverse) # ggplot2, dplyr, tidyr, readr, purrr, tibble
library(magrittr) # pipes
library(readxl) # excel
library(scales) # scales for ggplot2
library(jsonlite) # json
library(lintr) # code linting
library(sf) # spatial data handling
library(rmarkdown) # Import libraries
library(tidyverse) # collection of R packages designed for data science
# Vector
library(sf) ## GIS vector library new
library(sp) ## GIS vector library old
# Raster
library(raster) ## GIS raster library
# Visualization
library(RColorBrewer) ## ready-to-use color palettes for creating beautiful graphics
library(rmapshaper) ## used to simplify geometries
library(tmap) ## easy to use approach to to create theamtic maps
library(mapview) ## interactive visualisations of spatial data
library(classInt) ## methods for choosing univariate class intervals for mapping or other graphics purpo
file = "manifest.R")
```

Install packages

```
# if checkpoint is not yet installed, install it (for people using this
# system for the first time)
if (!require(checkpoint)) {
  if (!require(devtools)) {
    install.packages("devtools", repos = "http://cran.us.r-project.org")
    require(devtools)
  }
  devtools::install_github("RevolutionAnalytics/checkpoint",
                           ref = "v0.3.2", # could be adapted later,
                           # as of now (beginning of July 2017
                           # this is the current release on CRAN)
                           repos = "http://cran.us.r-project.org")
  require(checkpoint)
}
# nolint start
if (!dir.exists("~/.checkpoint")) {
  dir.create("~/.checkpoint")
}
# nolint end
# install packages for the specified CRAN snapshot date
checkpoint(snapshotDate = package_date,
           project = path_to_wd,
           verbose = T,
           scanForPackages = T,
           use.knitr = F,
           R.version = R_version)
rm(package_date)
```

Load packages

```
source("manifest.R")
unlink("manifest.R")
sessionInfo()
```

```
## R version 3.6.1 (2019-07-05)
## Platform: i386-w64-mingw32/i386 (32-bit)
## Running under: Windows 10 x64 (build 18362)
##
## Matrix products: default
##
## locale:
## [1] LC_COLLATE=German_Switzerland.1252  LC_CTYPE=German_Switzerland.1252
## [3] LC_MONETARY=German_Switzerland.1252 LC_NUMERIC=C
## [5] LC_TIME=German_Switzerland.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] classInt_0.4-1     mapview_2.7.0      tmap_2.3-1
##  [4] rmapshaper_0.4.1   RColorBrewer_1.1-2 raster_3.0-2
##  [7] sp_1.3-1           rmarkdown_1.15     sf_0.7-7
## [10] lintr_1.0.3        jsonlite_1.6       scales_1.0.0
## [13] readxl_1.3.1       magrittr_1.5       forcats_0.4.0
## [16] stringr_1.4.0      dplyr_0.8.3        purrr_0.3.2
## [19] readr_1.3.1        tidyr_1.0.0        tibble_2.1.3
## [22] ggplot2_3.2.1      tidyverse_1.2.1    rstudioapi_0.10
## [25] checkpoint_0.4.7
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.2         knitr_1.25         xml2_1.2.2
##  [4] units_0.6-4        hms_0.5.1          rvest_0.3.4
##  [7] tidyselect_0.2.5   viridisLite_0.3.0  xtable_1.8-4
## [10] jsonvalidate_1.1.0 colorspace_1.4-1   lattice_0.20-38
## [13] R6_2.4.0           rlang_0.4.0        rgdal_1.4-4
## [16] broom_0.5.2        xfun_0.9           e1071_1.7-2
## [19] modelr_0.1.5       withr_2.1.2        rgeos_0.5-1
## [22] leafsync_0.1.0     htmltools_0.3.6    class_7.3-15
## [25] leaflet_2.0.2      assertthat_0.2.1   digest_0.6.20
## [28] httpcode_0.2.0     lifecycle_0.1.0    shiny_1.3.2
## [31] crul_0.8.4         curl_4.0           haven_2.1.1
## [34] compiler_3.6.1     cellranger_1.1.0   pillar_1.4.2
## [37] backports_1.1.4    generics_0.0.2     stats4_3.6.1
## [40] geojsonlint_0.3.0  satellite_1.0.1    lubridate_1.7.4
## [43] httpuv_1.5.2       pkgconfig_2.0.2    rex_1.1.2
## [46] munsell_0.5.0      httr_1.4.1         tools_3.6.1
## [49] webshot_0.5.1      dichromat_2.0-0    grid_3.6.1
## [52] nlme_3.1-140       gtable_0.3.0       png_0.1-7
## [55] KernSmooth_2.23-15 DBI_1.0.0          cli_1.1.0
## [58] crosstalk_1.0.0    lazyeval_0.2.2     yaml_2.2.0
## [61] lwgeom_0.1-7       crayon_1.3.4       later_0.8.0
## [64] base64enc_0.1-3    tmaptools_2.0-2    htmlwidgets_1.3
```

```
## [67] promises_1.0.1     codetools_0.2-16   vctrs_0.2.0
## [70] zeallot_0.1.0      mime_0.7           glue_1.3.1
## [73] evaluate_0.14      V8_2.3             stringi_1.4.3
## [76] XML_3.98-1.20
```

Load additional scripts

```
# if you want to outsource logic to other script files, see README for
# further information
knitr::read_chunk("scripts/my_script.R")
source("scripts/my_script.R")
my_function(5)
```

```
## [1] 5
```

##Import data ##Public transportation stops The public transportation stops dataset was downloded here: https://data.geo.admin.ch/ch.bav.haltestellen-oev/data.zip Release date: 06-08-2018 Format: csv

```
# Import csv as df
pts_df <- read.csv("./Data_in/Betriebspunkt.csv", stringsAsFactors=FALSE, header= TRUE)

# Select desired attributes
pts_df <- pts_df %>%
  dplyr::select(pts_ID = "Nummer", pts_MunNr = "GdeNummer", "y_Koord_Ost", "x_Koord_Nord")
# !! There is a small mistake in this dataset: The X and Y values are swapped. Correctly, the attributes

# Convert df to spatial df
pts_sf <- sf::st_as_sf(x = pts_df, coords = c("y_Koord_Ost", "x_Koord_Nord"), crs= 2056) # epsg:2056 is

# Check data
class(pts_df)
```

```
## [1] "data.frame"
```

```
## [1] "data.frame"
pts_df[1:5,]
```

```
##    pts_ID pts_MunNr y_Koord_Ost x_Koord_Nord
## 1 8508186       338     2628463      1220751
## 2 8587698      6173     2643683      1132003
## 3 8531188      6252     2613318      1109828
## 4 8530051      5409     2572770      1129980
## 5 8501442      6057     2650331      1141959
```

```
##    pts_ID pts_MunNr y_Koord_Ost x_Koord_Nord
## 1 8508186       338     2628463      1220751
## 2 8587698      6173     2643683      1132003
## 3 8531188      6252     2613318      1109828
## 4 8530051      5409     2572770      1129980
## 5 8501442      6057     2650331      1141959

class(pts_sf)
```

```
## [1] "sf"         "data.frame"
```

```
## [1] "sf"         "data.frame"
pts_sf[1:5,]
```

```
## Simple feature collection with 5 features and 2 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: 2572770 ymin: 1109828 xmax: 2650331 ymax: 1220751
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
##    pts_ID pts_MunNr                geometry
## 1 8508186       338 POINT (2628463 1220751)
## 2 8587698      6173 POINT (2643683 1132003)
## 3 8531188      6252 POINT (2613318 1109828)
## 4 8530051      5409 POINT (2572770 1129980)
## 5 8501442      6057 POINT (2650331 1141959)
```

```
## Simple feature collection with 5 features and 2 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: 2572770 ymin: 1109830 xmax: 2650330 ymax: 1220750
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
##    pts_ID pts_MunNr                geometry
## 1 8508186       338 POINT (2628463 1220751)
## 2 8587698      6173 POINT (2643683 1132003)
## 3 8531188      6252 POINT (2613318 1109828)
## 4 8530051      5409 POINT (2572770 1129980)
## 5 8501442      6057 POINT (2650331 1141959)
```

Municipality

The municipality dataset was downloded here: https://shop.swisstopo.admin.ch/de/products/landscape/boundaries3D Release date: 2019 Format: Shapefile

```
# Import shp as spatial df
mun_sf <- sf::st_read("./Data_in/swissBOUNDARIES3D_1_3_TLM_HOHEITSGEBIET.shp", stringsAsFactors = FALSE
```

```
## Reading layer `swissBOUNDARIES3D_1_3_TLM_HOHEITSGEBIET' from data source `E:\R_github\R_AS_GIS\analys
## Simple feature collection with 2361 features and 23 fields
## geometry type:  POLYGON
## dimension:      XYZ
## bbox:           xmin: 2485410 ymin: 1075268 xmax: 2833858 ymax: 1295934
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
```

```
## Reading layer `swissBOUNDARIES3D_1_3_TLM_HOHEITSGEBIET' from data source `C:\gitrepos\R_AS_GIS\Data_
## Simple feature collection with 2361 features and 23 fields
## geometry type:  POLYGON
## dimension:      XYZ
## bbox:           xmin: 2485410 ymin: 1075270 xmax: 2833860 ymax: 1295930
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y

# Select desired attributes
mun_sf <- mun_sf %>%
  dplyr::select(mun_MunNr = "BFS_NUMMER", mun_CanNr = "KANTONSNUM") %>%
  dplyr::group_by(mun_MunNr)%>%
  dplyr::summarize(
    mun_CanNr = unique(mun_CanNr)
```

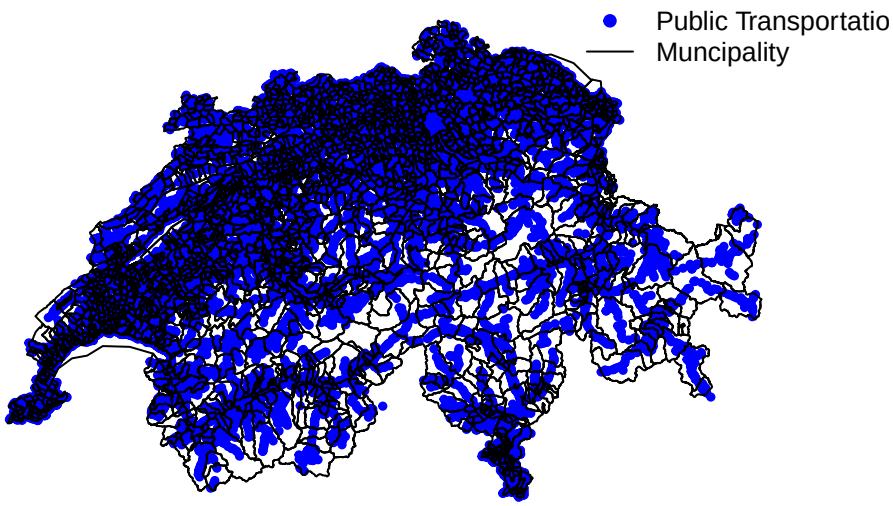
```
    ) %>%
  st_zm(drop =  TRUE)

# Check data
class(mun_sf)
```

```
## [1] "sf"         "tbl_df"     "tbl"        "data.frame"
```

```
## [1] "sf"         "tbl_df"     "tbl"        "data.frame"

mun_sf[1:5,]
```

```
## Simple feature collection with 5 features and 2 fields
## geometry type:  POLYGON
## dimension:      XY
## bbox:           xmin: 2673826 ymin: 1230185 xmax: 2686463 ymax: 1243159
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
## # A tibble: 5 x 3
##   mun_MunNr mun_CanNr                                            geometry
##       <int>     <int>                                      <POLYGON [m]>
## 1         1         1 ((2680492 1235035, 2680482 1235041, 2680473 1235046,~
## 2         2         1 ((2674714 1236942, 2674699 1237008, 2674689 1237061,~
## 3         3         1 ((2679008 1241960, 2679015 1241965, 2679022 1241971,~
## 4         4         1 ((2686028 1230192, 2686026 1230195, 2686024 1230205,~
## 5         5         1 ((2678523 1238540, 2678511 1238544, 2678431 1238561,~
```

```
## Simple feature collection with 5 features and 2 fields
## geometry type:  POLYGON
## dimension:      XY
## bbox:           xmin: 2673830 ymin: 1230190 xmax: 2686460 ymax: 1243160
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
## # A tibble: 5 x 3
##   mun_MunNr mun_CanNr                                            geometry
##       <int>     <int>                                      <POLYGON [m]>
## 1         1         1 ((2680492 1235035, 2680482 1235041, 2680473 1235046,~
## 2         2         1 ((2674714 1236942, 2674699 1237008, 2674689 1237061,~
## 3         3         1 ((2679008 1241960, 2679015 1241965, 2679022 1241971,~
## 4         4         1 ((2686028 1230192, 2686026 1230195, 2686024 1230205,~
## 5         5         1 ((2678523 1238540, 2678511 1238544, 2678431 1238561,~

# Plot imported data: R base plot
plot(st_geometry(pts_sf), pch = 19, col="blue", cex = 0.5)
plot(st_geometry(mun_sf), add = TRUE)
legend(x=2750000,y=1310000,
       c("Public Transportation Stops","Muncipality"),
       lty=c(NA,1),
       pch=c(19,NA),
       cex=.8,
       col=c("blue","black"),
       bty='n'
       )
```



##Calculate density of public transportation stops per municipality

```
# Spatial Join: instead of joining dataframes via an equal ID we join data- frames based on an equal lo
spjoin_sf <- sf::st_join(pts_sf, mun_sf)

spjoin_sf
```

```
## Simple feature collection with 26895 features and 4 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: 2486195 ymin: 1075525 xmax: 2831996 ymax: 1294167
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
## First 10 features:
##     pts_ID pts_MunNr mun_MunNr mun_CanNr                geometry
## 1  8508186       338       338         2 POINT (2628463 1220751)
## 2  8587698      6173      6173        23 POINT (2643683 1132003)
## 3  8531188      6252      6252        23 POINT (2613318 1109828)
## 4  8530051      5409      5409        22 POINT (2572770 1129980)
## 5  8501442      6057      6057        23 POINT (2650331 1141959)
## 6  8583656      6702      6702        26 POINT (2584548 1246665)
## 7  8590028       351       351         2 POINT (2599934 1200621)
## 8  8579143      5871      5871        22 POINT (2509845 1163460)
## 9  8572195      2788      2788        13 POINT (2599991 1249781)
## 10 8576536       576       576         2 POINT (2643212 1163308)
```

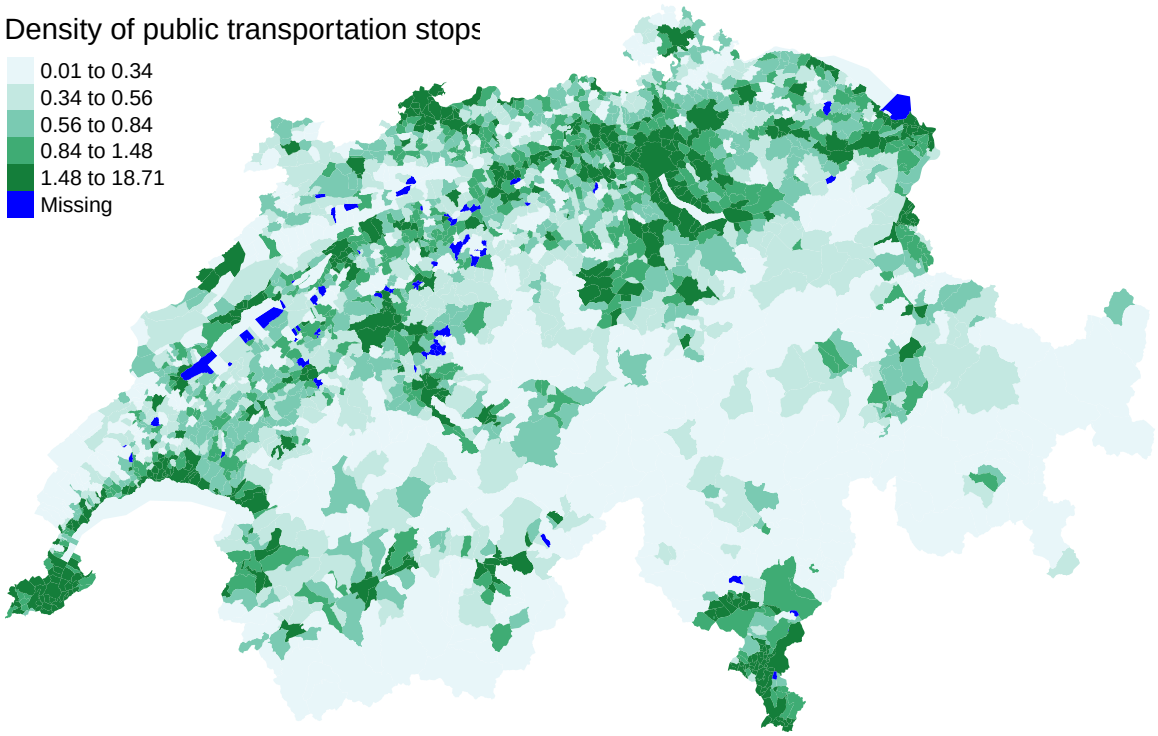
```
## Simple feature collection with 26895 features and 4 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: 2486200 ymin: 1075520 xmax: 2832000 ymax: 1294170
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +
## First 10 features:
##     pts_ID pts_MunNr mun_MunNr mun_CanNr                 geometry
## 1  8508186       338       338         2 POINT (2628463 1220751)
## 2  8587698      6173      6173        23 POINT (2643683 1132003)
## 3  8531188      6252      6252        23 POINT (2613318 1109828)
## 4  8530051      5409      5409        22 POINT (2572770 1129980)
## 5  8501442      6057      6057        23 POINT (2650331 1141959)
## 6  8583656      6702      6702        26 POINT (2584548 1246665)
## 7  8590028       351       351         2 POINT (2599934 1200621)
## 8  8579143      5871      5871        22 POINT (2509845 1163460)
## 9  8572195      2788      2788        13 POINT (2599991 1249781)
## 10 8576536       576       576         2 POINT (2643212 1163308)
```

```
# Check: Did the Federal Office of Transport use the same municiaplity boundaries as we did in order to
spjoin_sf_check <-  spjoin_sf %>%
  dplyr::select(mun_MunNr,pts_MunNr) %>%
  dplyr::mutate (check = (spjoin_sf$mun_MunNr == spjoin_sf$pts_MunNr)) %>%
  dplyr::arrange(check)

table(spjoin_sf_check$check) #462/26408*100 = 1.75%
```

```
##
## FALSE  TRUE
##   475 26395
```

```
##
## FALSE  TRUE
##   475 26395
# ... no, they did not. Probably they used the same dataset with a different reference date.

# Density calculation

# > 1. Count points per polygon
pts_count <- spjoin_sf %>%
   dplyr::group_by(mun_MunNr) %>%
   dplyr::summarise(count=n())

mun_sf <- mun_sf %>%
  dplyr::left_join(pts_count %>% st_set_geometry(NULL) , by = c("mun_MunNr" ))

# > 2. Calculate area of polygon
mun_sf <- mun_sf %>%
  dplyr::mutate(mun_area_m2 =as.vector(sf::st_area(.)))

# > 3. Calculate density: count/area
mun_sf$density <- mun_sf$count / mun_sf$mun_area_m2 * 1000000

# Plot result: tmap
```

```
# > tmap static
tmap::tmap_mode("plot")
#tmap_mode("view")
tmap::tm_shape(mun_sf) +
  tmap::tm_fill("density",
          title="Density of public transportation stops",
          style="quantile",
          palette="BuGn",
          colorNA = "blue")  +
  tmap::tm_layout(frame = FALSE)
```



Calculate density of public transportation stops per canton

```
# group_by mun_CanNr
canton_sf <- mun_sf %>%
  dplyr::select(mun_CanNr,  count, mun_area_m2) %>%
  dplyr::group_by(mun_CanNr)%>%
  dplyr::summarize(
    count = sum(count, na.rm = TRUE),
    mun_area_m2 = sum(mun_area_m2,  na.rm = TRUE)
    )  %>%
  dplyr::mutate(
    density = round((count/mun_area_m2 * 1000000),1)
    )

# Plot result: ggplot
# Get quantile breaks. Add .00001 offset to catch the lowest value
```

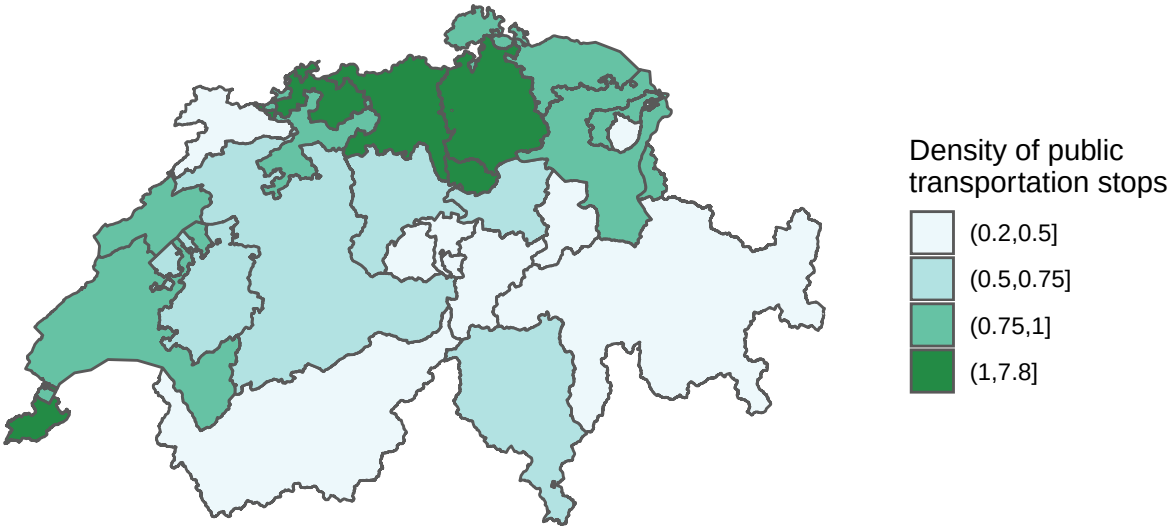
```
breaks_qt <- classInt::classIntervals(c(min(canton_sf$density) - .00001, canton_sf$density), n = 4, sty
breaks_qt$brks
```

```
## [1] 0.19999 0.50000 0.75000 1.00000 7.80000
```

```
## [1] 0.19999 0.50000 0.75000 1.00000 7.80000

# Use cut to divice density into intervals and code them according to which interval they are in.
canton_sf <- canton_sf %>%
   dplyr::mutate(mycat = cut(density, breaks_qt$brks)) %>%
   dplyr::arrange(density)
canton_sf$mycat
```

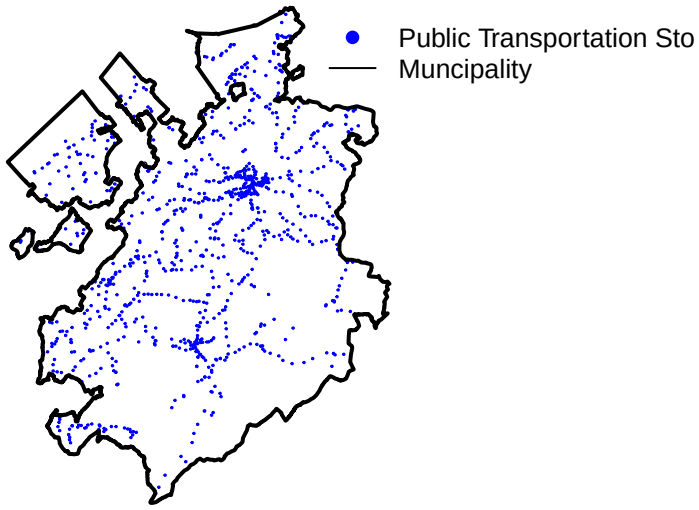
```
##  [1] (0.2,0.5]  (0.2,0.5]  (0.2,0.5]  (0.2,0.5]  (0.2,0.5]  (0.2,0.5]
##  [7] (0.2,0.5]  (0.2,0.5]  (0.5,0.75] (0.5,0.75] (0.5,0.75] (0.5,0.75]
## [13] (0.5,0.75] (0.75,1]   (0.75,1]   (0.75,1]   (0.75,1]   (0.75,1]
## [19] (0.75,1]   (0.75,1]   (0.75,1]   (1,7.8]    (1,7.8]    (1,7.8]
## [25] (1,7.8]    (1,7.8]    (1,7.8]
## Levels: (0.2,0.5] (0.5,0.75] (0.75,1] (1,7.8]
```

```
##  [1] (0.2,0.5]  (0.2,0.5]  (0.2,0.5]  (0.2,0.5]  (0.2,0.5]  (0.2,0.5]
##  [7] (0.2,0.5]  (0.2,0.5]  (0.5,0.75] (0.5,0.75] (0.5,0.75] (0.5,0.75]
## [13] (0.5,0.75] (0.75,1]   (0.75,1]   (0.75,1]   (0.75,1]   (0.75,1]
## [19] (0.75,1]   (0.75,1]   (0.75,1]   (1,7.8]    (1,7.8]    (1,7.8]
## [25] (1,7.8]    (1,7.8]    (1,7.8]
## Levels: (0.2,0.5] (0.5,0.75] (0.75,1] (1,7.8]

ggplot2::ggplot(canton_sf) +
    geom_sf(aes(fill=mycat)) +
    scale_fill_brewer(palette = "BuGn", name = "Density of public\ntransportation stops")  +
    coord_sf(datum=NA) + # no coordinate grid
    theme_bw() +# background = white
    theme(
      panel.border = element_blank() # no border line around plot
      )
```

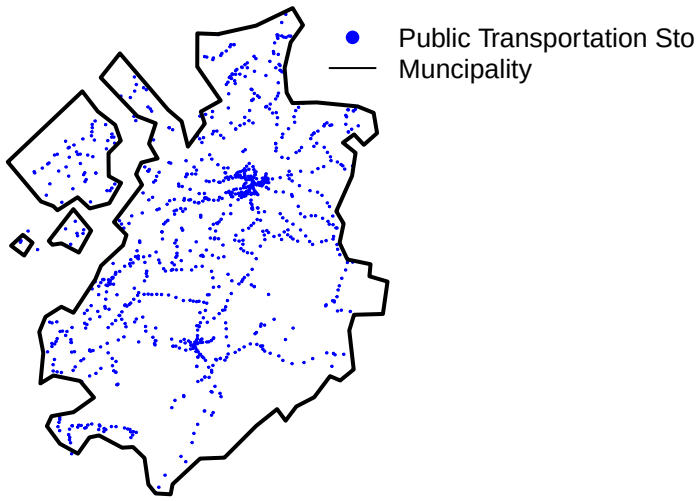


Filter by canton: Freiburg

```
# Filter mun_CanNr == 10
pts_freiburg<- spjoin_sf %>%
    dplyr::filter(mun_CanNr == 10)

canton_freiburg <- canton_sf %>%
  dplyr::filter(mun_CanNr == 10)

# Plot result: R base plot
plot(st_geometry(pts_freiburg), pch = 19, col="blue", cex = 0.1)
plot(st_geometry(canton_freiburg), lwd = 2, add = TRUE)
legend(x=2587000 ,y=1206350,
       c("Public Transportation Stops","Muncipality"),
       lty=c(NA,1),
       pch=c(19,NA),
       cex=.8,
       col=c("blue","black"),
       bty='n'
       )
```




```
# This plot contains a lot of data as it contains a lot of coordinates. Do we really need this level of

# Reduce level of detail
canton_freiburg_gen <- rmapshaper::ms_simplify(canton_freiburg, keep = 0.01, keep_shapes = TRUE)
plot(st_geometry(pts_freiburg), pch = 19, col="blue", cex = 0.1)
plot(st_geometry(canton_freiburg_gen), lwd = 2, add = TRUE)
legend(x=2587000 ,y=1206350,
       c("Public Transportation Stops","Muncipality"),
       lty=c(NA,1),
       pch=c(19,NA),
       cex=.8,
       col=c("blue","black"),
       bty='n'
       )
```

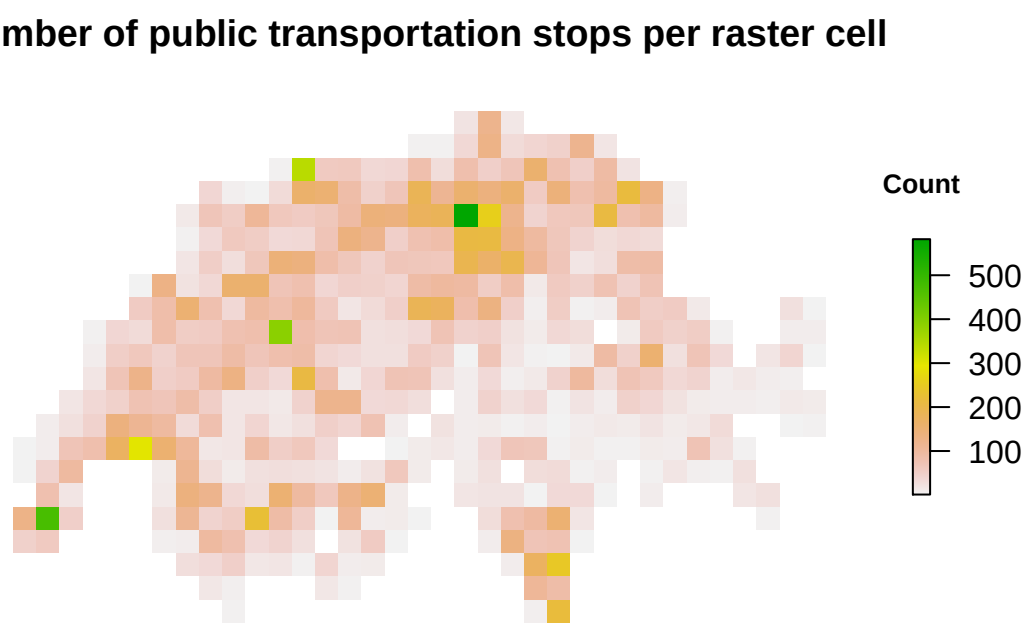


Calculate number of public transportation stops per raster cells

```
# We will use the sp package to carry out this analysis because point pattern analysis is still more es

# sf to sp
pts_sp <- as(pts_sf, Class = "Spatial")

# Create grid with raster cell size 10'000 x 10'000m
boundingbox_pts_sp = as(extent(pts_sp), "SpatialPolygons")
r = raster::raster(boundingbox_pts_sp, resolution = 10000)
crs(r) <- CRS('+init=EPSG:2056')

# Count points per raster cell
rc = raster::rasterize(pts_sp@coords, r, fun = "count")

rc
```

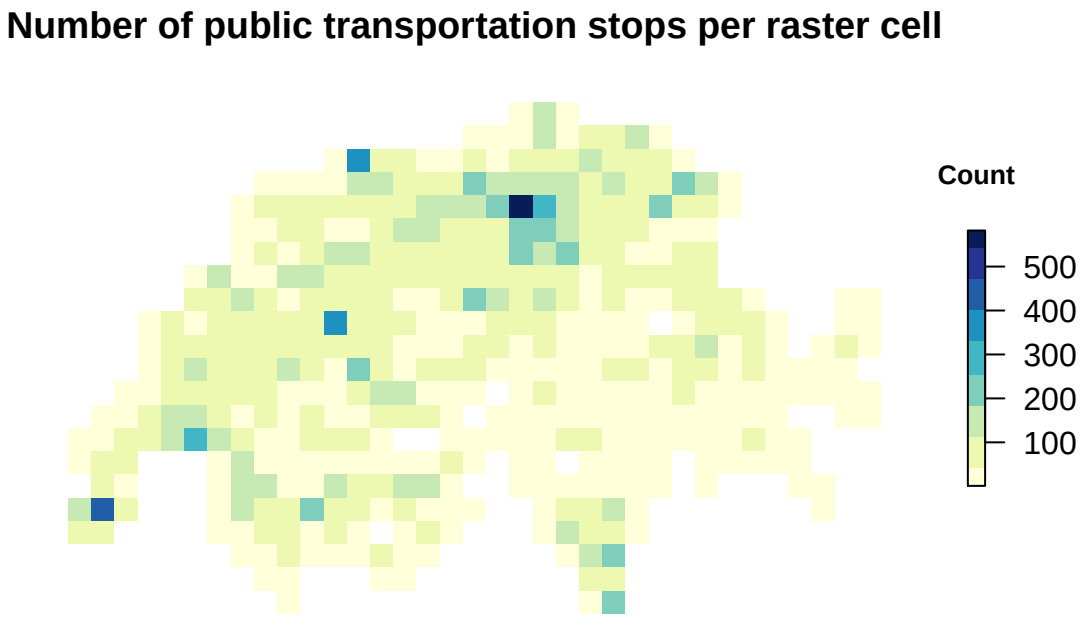
```
## class      : RasterLayer
## dimensions : 22, 35, 770  (nrow, ncol, ncell)
## resolution : 10000, 10000  (x, y)
## extent     : 2486195, 2836195, 1074167, 1294167  (xmin, xmax, ymin, ymax)
## crs        : +init=EPSG:2056 +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +
## source     : memory
## names      : layer
## values     : 1, 582  (min, max)
```

```
## class       : RasterLayer
## dimensions  : 22, 35, 770  (nrow, ncol, ncell)
## resolution  : 10000, 10000  (x, y)
## extent      : 2486195, 2836195, 1074167, 1294167  (xmin, xmax, ymin, ymax)
## coord. ref. : +init=EPSG:2056 +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1
## data source : in memory
## names       : layer
## values      : 1, 582  (min, max)

# Plot result: raster plot
raster::plot(rc,
     bty="n",
     box=FALSE,
     xaxt = "n",
     yaxt = "n",
     legend.args = list(text = 'Count', cex = 0.8, line = 1, font = 2),
      main="Number of public transportation stops per raster cell")
```




```
# As many as 8 percent of men and 0.5 percent of women with Northern European ancestry have the common

my.palette = RColorBrewer::brewer.pal(n = 9, name = "YlGnBu")
raster::plot(rc,
             col = my.palette,
             bty="n",
             box=FALSE,
             xaxt = "n", yaxt = "n",
```

```
            legend.args = list(text = 'Count', cex = 0.8, line = 1, font = 2),
            main="Number of public transportation stops per raster cell")
```



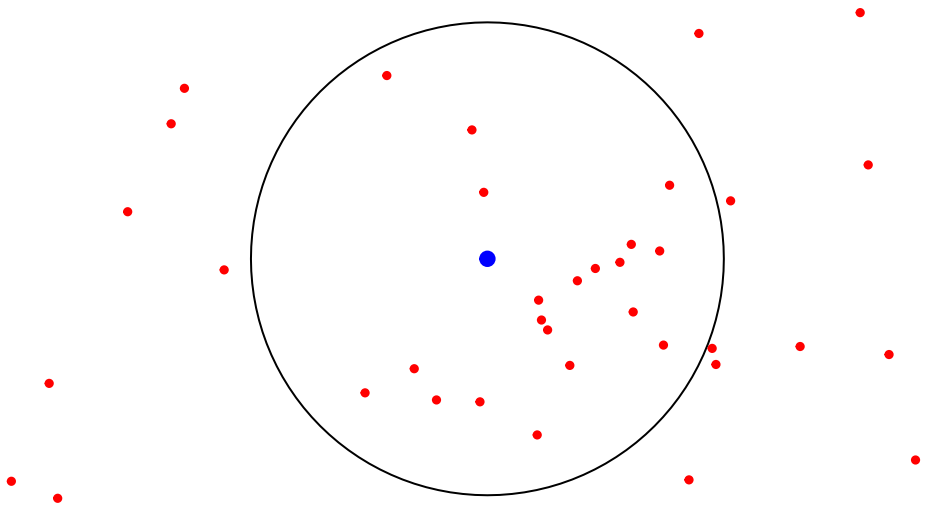
##Count number of public transportation stops in a defined area

```
# Somdbody asked us to calculate the number of public transportation stops 500m around this coordinate:
N <- 47.37861
E <- 8.53768

# Create df
mypoint_df <-  data.frame(N,E)

# Convert df to spatial df
mypoint_sf <- sf::st_as_sf(x = mypoint_df, coords = c("E", "N"), crs= 4326) %>%  #epsg:4326 is the ID o
  sf::st_transform(2056)

# Calculate area 500 m around mypoint_sf
myarea_sf <- mypoint_sf %>%
  sf::st_buffer(500) %>%
  dplyr::mutate(name = "MyArea")

# Count points per myarea_sf
spjoin_sf <- st_join(pts_sf, myarea_sf)

pts_count  <- spjoin_sf %>%
  dplyr::group_by(name) %>%
```

```
  dplyr::summarise(count=n())

pts_count
```

```
## Simple feature collection with 2 features and 2 fields
## geometry type:  MULTIPOINT
## dimension:      XY
## bbox:           xmin: 2486195 ymin: 1075525 xmax: 2831996 ymax: 1294167
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
## # A tibble: 2 x 3
##   name   count                                                  geometry
## * <chr>  <int>                                           <MULTIPOINT [m]>
## 1 MyArea    20 (2682739 1247828, 2682785 1248499, 2682843 1247879, 2682890~
## 2 <NA>   26875 (2486195 1111396, 2486530 1112028, 2486730 1111962, 2486957~
```

```
## Simple feature collection with 2 features and 2 fields
## geometry type:  MULTIPOINT
## dimension:      XY
## bbox:           xmin: 2486200 ymin: 1075520 xmax: 2832000 ymax: 1294170
## epsg (SRID):    2056
## proj4string:    +proj=somerc +lat_0=46.95240555555556 +lon_0=7.439583333333333 +k_0=1 +x_0=2600000 +y
## # A tibble: 2 x 3
##   name   count                                                  geometry
## * <chr>  <int>                                           <MULTIPOINT [m]>
## 1 MyArea    20 (2682739 1247828, 2682785 1248499, 2682843 1247879, 2682890~
## 2 <NA>   26875 (2486195 1111396, 2486530 1112028, 2486730 1111962, 2486957~

# Plot result: R base plot
plot(st_geometry(myarea_sf, col="grey",border="black"))
plot(st_geometry(mypoint_sf), pch = 19, col="blue", cex =1, add = TRUE)
plot(st_geometry(pts_sf), pch = 19, col="red", cex =0.5, add = TRUE)
```



Export Data

```
# shp
sf::st_write(canton_freiburg_gen, "./Data_out/canton_freiburg_gen.shp", delete_layer = TRUE)
```

```
## Deleting layer `canton_freiburg_gen' using driver `ESRI Shapefile'
## Writing layer `canton_freiburg_gen' to data source `./Data_out/canton_freiburg_gen.shp' using driver
## features:       1
## fields:         5
## geometry type:  Multi Polygon
```

```
## Deleting layer `canton_freiburg_gen' using driver `ESRI Shapefile'
## Writing layer `canton_freiburg_gen' to data source `./Data_out/canton_freiburg_gen.shp' using driver
## features:       1
## fields:         5
## geometry type:  Multi Polygon

# json
path_4326 = "./Data_out/mun_join_pt_sf_freiburg_gen.json"
file.remove(path_4326)
```

```
## [1] TRUE
```

```
## [1] TRUE
sf::st_write(canton_freiburg_gen %>% st_transform(4326), path_4326, driver="GeoJSON")
```

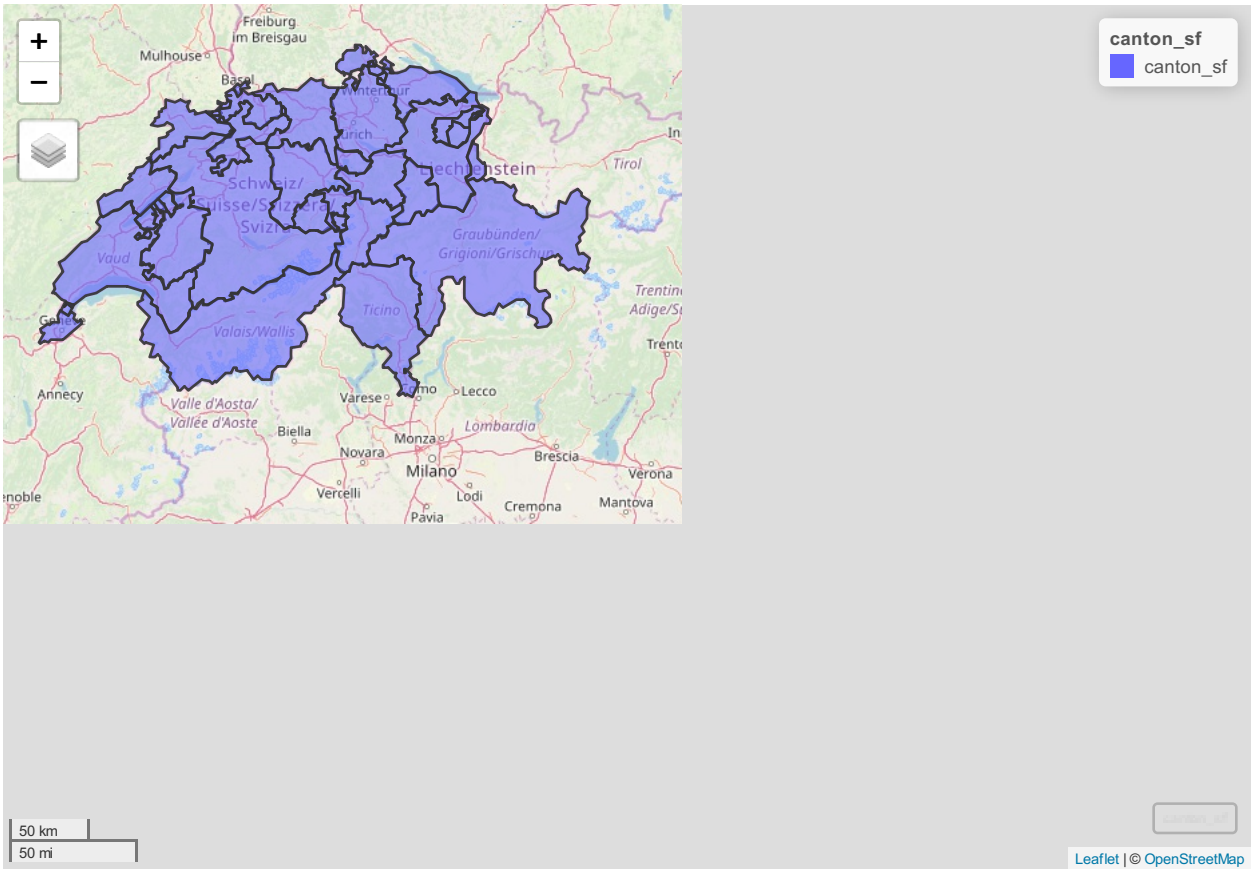
```
## Writing layer `mun_join_pt_sf_freiburg_gen' to data source `./Data_out/mun_join_pt_sf_freiburg_gen.j
```

```
## features:       1
## fields:         5
## geometry type:  Multi Polygon
```

```
## Writing layer `mun_join_pt_sf_freiburg_gen' to data source `./Data_out/mun_join_pt_sf_freiburg_gen.j
## features:       1
## fields:         5
## geometry type:  Multi Polygon

# tif
raster::writeRaster(rc, filename= "./Data_out/rc.tif", format="GTiff", overwrite=TRUE)
```

Which canton has the longest border?

```
# Calculate line length
canton_line_sf <- canton_sf %>%
   sf::st_cast("MULTILINESTRING") %>%
   dplyr::mutate(length_km = round(as.vector(as.vector(sf::st_length(.)))/1000,digits = 0))

canton_sf <-canton_sf %>%
 dplyr::mutate(
 length_km =   canton_line_sf$length_km
  ) %>%
 dplyr::arrange(desc(length_km))

# Print result
mapview::mapview(canton_sf,
           map.types = c("OpenStreetMap")
          )
```


canton_sf
canton_sf
Freiburg
im Breisgau
Mulhouse
Basel
Zürich
Liechtenstein
Tirol
Graubünden/
Grigioni/Grischun
Ticino
Valais/Wallis
Vaud
Annecy
Valle d'Aosta/
Vallée d'Aoste
Biella
Varese
Lecco
Lombardia
Monza
Novara
Milano
Brescia
Verona
Vercelli
Lodi
Cremona
Mantova
Pavia
50 km
50 mi
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