

**Department of Geography** 

# GEO 812 Getting started with R for Spatial Analysis

# Session 4: Spatial data and maps

Peter Ranacher September 2019

#### Learning objectives for Session 4

You are able to

- name the main spatial data types in R
- import spatial data from different sources
- turn data with coordinates to spatial data (sp and sf)
- create maps with leaflet and ggplot

#### Before we start...

We need the data collected in class

Basic spatial data types

Which spatial data types do you know?



#### Packages to analyze spatial data

- $\operatorname{sp}-\operatorname{classes}$  and methods for spatial data
- ${\tt sf}-{\tt yet}$  other classes and methods for spatial data
- leaflet interactive maps
- (rgdal for projection/transformation operation)

#### Load and attach packages:

```
library(sp)
```

```
library(sf)
```

```
library(leaflet)
```

```
library(rgdal)
```

# $\operatorname{sp}\operatorname{and}\operatorname{sf}$

sp

- traditional package for spatial analysis in R
- loads of GIS functions
- **but** not always compatible with mainstream R packages and data structures

# sf

- fairly new package
- compatible with mainstream R (especially the tidyverse!)
- but many, many GIS functions still rely on  ${\rm sp}$

sf is meant to replace sp in the meantime  $\rightarrow$  one should know both.



# ${\tt sp} \text{ and } {\tt sf}: \text{ similarities and differences}$

Both packages are designed to represent spatial features, that is objects with a



#### but

 $\operatorname{sp}$  and  $\operatorname{sf}$  store information about geometry and attributes differently

sp has a separate class for each spatial data type

 ${\tt sf}$  uses data frames that also contain spatial data

# In $\operatorname{sp}:$ one class per spatial data type

	With attributes	Without attributes	
Vector	SpatialPointsDataFrame	SpatialPoints	• • •
	SpatialLinesDataFrame	SpatialLines	$\sim$
	SpatialPolygonsDataFrame	SpatialPolygons	$\frown$
Raster	SpatialGridDataFrame	SpatialGrid	

# And in sf?

#### A data frame where

- rows are simple features
- columns are attributes
- one column is a simple geometry column (sfc) consisting of simple feature geometries (sfg)



geometry column (sfc)

## Turn data frame into ${\tt sp}$

columns with coordinates

coordinate reference system

CRS () turns a string into a proj4 string.



Q: What is a proj4 string?

A: https://www.earthdatascience.org/courses/earth-analytics/spatial-data-r/understand-epsg-wkt-and-other-crs-definition-file-types/





Q: 4326? A: https://www.earthdatascience.org/courses/earth-analytics/spatial-datar/understand-epsg-wkt-and-other-crs-definition-file-types/

Convert from  ${\tt sp} \ to \ {\tt sf}$  and back

From sp to sf
st\_as\_sf(stats\_geo812\_sp)

From sf to sp
as(stats geo812 sf, Class="Spatial")



And now... let's make some maps!

## Get some map data!

#### Country borders of the world

countries\_url <- "https://raw.githubusercontent.com/johan/world.geo.json/master/countries.geo.json"</pre>

#### Read country borders and turn into ${\tt sf}$

countries <- st read(countries url)</pre>

#### We can use name for selecting countries

```
index_ch <- countries$name == "Switzerland"</pre>
```

```
switzerland <- countries[index_ch, ]</pre>
```

#### Remove Antarctica (might mess up the map)

```
index_ant <- countries$name != "Antarctica"
countries <- countries[index_ant, ]</pre>
```



#### Making maps



Offline map without interaction

 $\rightarrow$  For reports, scientific publications, journals

 $\rightarrow$  For sf



Online web mapping with a lot of bling bling

- $\rightarrow$  For interactive maps
- → For sp and sf

tmap

The new kids on the block

 $\rightarrow$  Both for online and offline mapping



#### The (reduced) layered grammar of graphics in ggplot

```
ggplot(data = <DATA>) +
    <GEOM_FUNCTION>(
        mapping = aes(<MAPPINGS>)) +
    <COORDINATE_FUNCTION>
```

<DATA>
<GEOM FUNCTION>
<MAPPING>
<COORDINATE\_FUNCTION>

What do you plot? Which plotting function (*geom*) do you use? How are the data mapped to the aesthetics? In which coordinate system are the *geoms* placed?

### Plot Switzerland (and the world) with ggplot

#### <DATA>

<MAPPING>

<DATA>

<GEOM FUNCTION>

geom\_sf(aes(), fill = "grey", alpha = 0.2) +

<GEOM FUNCTION>

geom sf(data = switzerland, aes(),fill = "red") +

<MAPPING>

#### <COORDINATE FUNCTION>

 $coord_sf(crs = st_crs(54012), datum = NA) +$ 

theme\_void()



theme\_void()?
No background, no grid, no
nothing.

# That's where I am from. According to you.



This is where I am actually from.



# A choropleth map in ggplot: merging the data

#### Count your guesses per country

```
country_freq <- group_by(stats_geo812, i_am_from) %>%
summarise (n = n()) %>%
mutate(freq = n / sum(n))
```

#### Merge with countries (sf object)



merge():by.x and by.y are the corresponding entries
in the two data frames (in our case the country names)

#### A choropleth map in ggplot: mapping!

bounding box, defines the map extent

```
bbox <- st bbox(st transform(your guess, st crs(3785)))</pre>
ggplot(your_guess) + background map
 geom sf(data = countries, aes(), fill = "grey") +
 geom sf(aes(fill = freq), alpha = 0.8) +
                   choropleth map
 theme void () +
         coord sf(xlim = bbox[c(1,3)]),
         crs = st_crs(3785), ---- reproject to Mercator (for visualization only)
         datum = NA) +
                                        legend
 scale_fill_continuous(trans = "reverse",
                    guide=guide colourbar(reverse = TRUE,
                                       title = "Frequency"))
```

# Reprojecting spatial data

requires the rgdal package

What is the projection of my data? For sp: proj4string(stats\_geo812\_sp) For sf: st\_crs(stats\_geo812\_sf)

HAT YOUR FAVORITE

```
      Reprojecting
      spatial data
      coordinate reference system to project the data to

      For sp:
      \spTransform(stats_geo812_sp, CRS("+proj=longlat +ellps=GRS80"))

      For sf:
      st_transform(stats_geo812_sf, CRS("+proj=longlat +ellps=GRS80"))
```

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VAN DER GRINTEN

The only GIS slide

Who of you has spent their holidays in Switzerland?



#### holidays\_in\_ch\_sf <- st\_join(stats\_geo812\_sf,</pre>

switzerland, st\_within, left=F)





## What can we plot in a leaflet map?

- A basemap
- Markers and popups
- Polygons circles and lines





A legend



#### Add a basemap

addTiles() - add a basemap: default OpenStreetMap
addProviderTiles("Stamen.Toner") - add Stamen Toner map





#### Add markers with popups



Add markers with popup window

addMarkers(popup = "your popup text here")

#### Set the map extent

- setView(): sets the center of the map view and the zoom level
- fitBounds(): fits the map into the rectangle lng1, lat1, lng2, lat2

#### Example:

```
map_zh <- leaflet() %>%
   addTiles() %>%
   setView (lat = 47.4, lng = 8.5, zoom = 10)
```

```
map_zh
```

## An interactive map in leaflet (sp)

```
map <- leaflet(data = stats_geo812_sp) %>%
   addTiles() %>%
   addMarkers(popup = ~as.character(why_here))
map
```

Summary:

- 2. Add features to the map
- 3. Print the map widget

#### Exercise 7:

Where in Zurich do the students in GEO812 live?

- download the Stadtkreise of Zurich as a GeoJSON (<u>https://data.stadt-</u> <u>zuerich.ch/dataset/stadtkreise</u>) or directly read the data into R
- count students per Stadtkreis (stats\_geo812\$kreis)
- combine the count data with the administrative data (merge)
- plot your results in two different ways using:
  - ggplot
  - and leaflet
- When using ggplot you might want to export your map. Use the function ggsave().
- When using leaflet you might want to have a look at how coloring choropleth maps works (<u>https://rstudio.github.io/leaflet/colors.html</u>)

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Plus, you know where I am from.