Introduction to PostGIS

Relational databases & GIS

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AG Landscape Ecology

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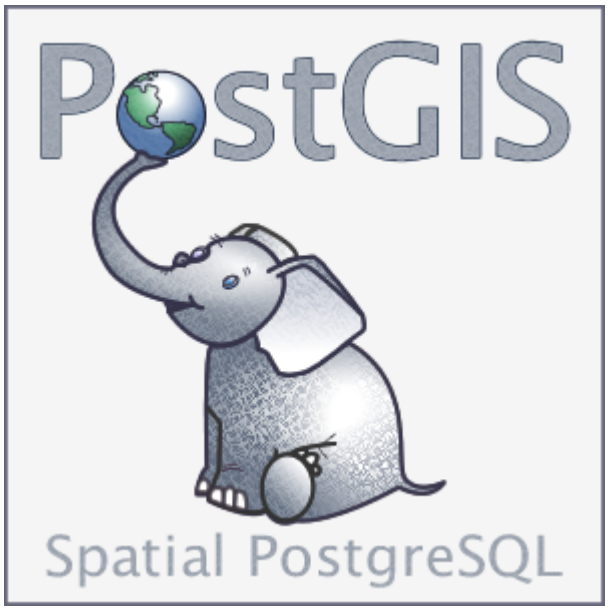
What is PostGIS ?

- It's FOSS!
- Spatial extension for the relational database PostgreSQL
- Compliant with the Open Geospatial Consortium (OGC) standards
  https://www.ogc.org
- Simple Feature Access
  https://en.wikipedia.org/wiki/Simple_Features
  - `ST_Area()`
  - `ST_Length()`
  - `ST_Intersection()`
  - `ST_Intersects()`
  - `...`

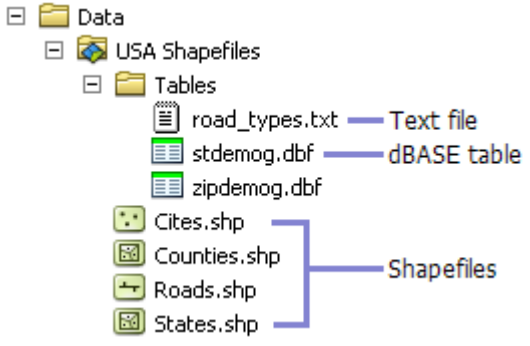
What is PostGIS ?

- Spatial extension for the relational database PostgreSQL
  - Geospatial Data Type
    - Point
    - Line
    - Polygon
    - Geometry Collection
    - Raster
  - (Spatial) Indices



Why not use a Shapefile?

ArcGIS (proprietary)




```
## cities.dbf
## cities.prj
## cities.shp
## cities.shx
```

PostGIS

city text	lon numeric	lat numeric	geom geometry
Lagos	3.3840	6.4550	0101000020E6100000DF4F8D976E120B4052B81E85EBD11940
Vienna	16.3666	48.2	0101000020E6100000AEB6627FD95D30409A99999999194840
Taipei	121.5166	25.0666	0101000020E6100000454772F90F615E40E2E995B20C113940
Brasilia	-47.8827	-15.7938	0101000020E6100000F0164850FCF047C02D211FF46C962FC0
Boston	-71.1043	42.3150	0101000020E6100000423EE8D9ACC651C0B81E85EB51284540

- Geo-Information
  - **One table**
  - **One Column**

Why not use a Shapefile?

- Easy data storage (comapared on standard GIS software)
- Standard simple feature formatting allows spatial data to be accessed by other software
- Automation of processes
- Handling of large data-sets

PostGIS

city text	lon numeric	lat numeric	geom geometry
Lagos	3.3840	6.4550	0101000020E6100000DF4F8D976E120B4052B81E85EBD11940
Vienna	16.3666	48.2	0101000020E6100000AEB6627FD95D30409A99999999194840
Taipei	121.5166	25.0666	0101000020E6100000454772F90F615E40E2E995B20C113940
Brasilia	-47.8827	-15.7938	0101000020E6100000F0164850FCF047C02D211FF46C962FC0
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- Geo-Information
  - **One table**
  - **One Column**

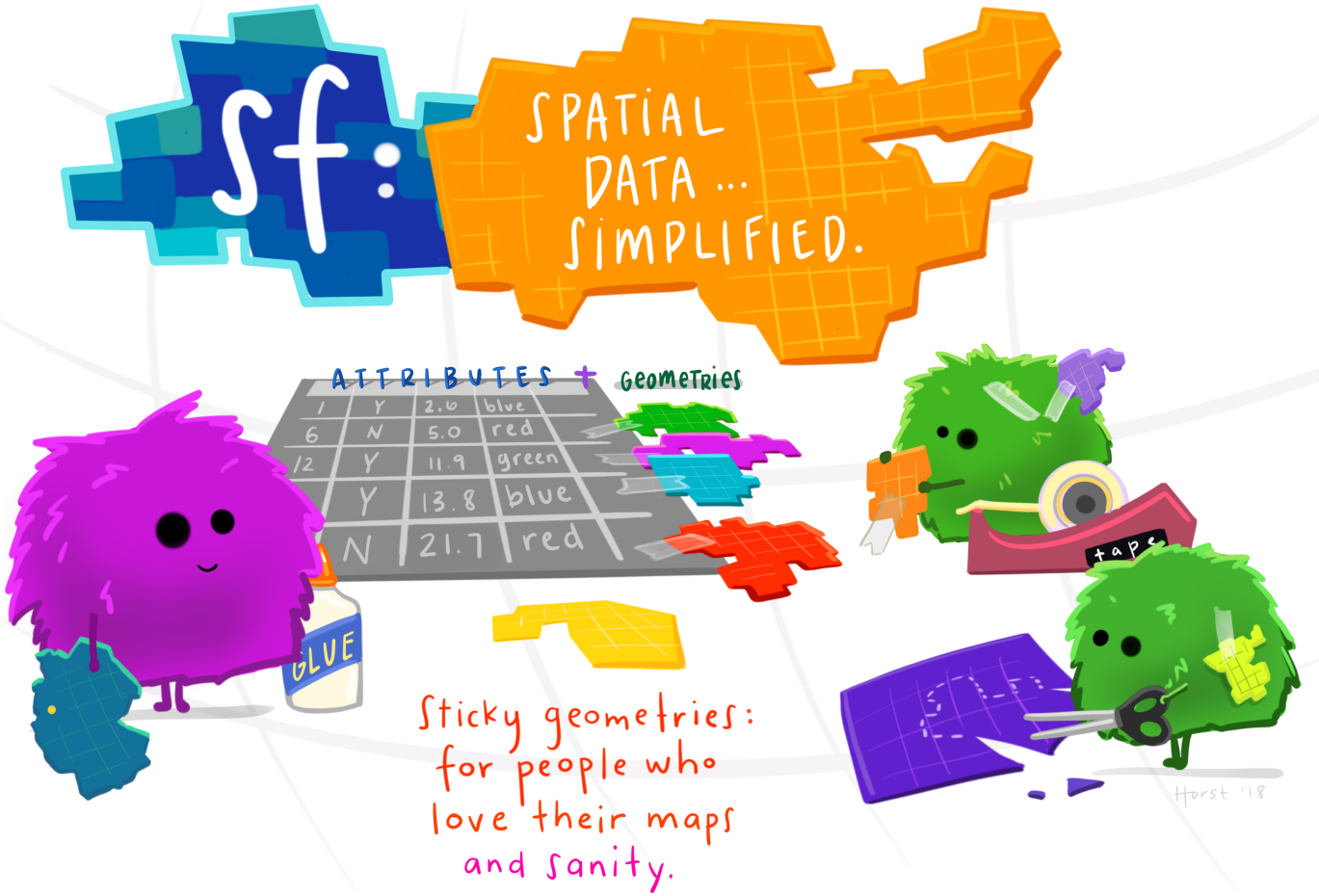


Illustration (c) by Allison Horst

Geo Libraries

- GDAL - Geo Data Abstraction Library

- GEOS - Geometry Engine, Open Source

- PROJ - Coordinate transformation software library

PostGIS functions

R {sf} equivalents

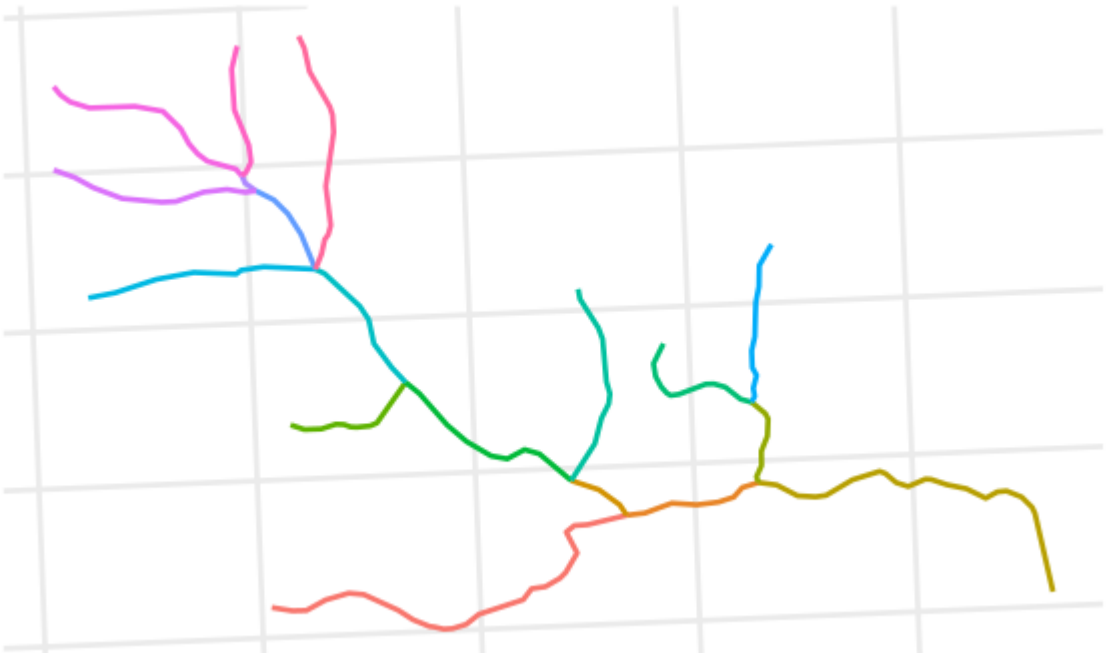
Palar River

Palar River

```
SELECT *
FROM palar
LIMIT 3
```

Palar River

length	pente	strahler	fid	geom
3053.50	20.366169	1	1194653	LINESTRING (4550796 2582247…
986.99	5.996377	2	1194668	LINESTRING (4553302 2582898…
476.30	11.744198	2	1194670	LINESTRING (4552910 2583143…



Union

```sql
SELECT ST_Union(geom) AS geom
FROM palar
```

```
palar |>
  st_union()
```

Length

```
SELECT ST_Length(ST_Union(geom)) geom
FROM palar
```

```
palar |>
  st_union() |>
  st_length()
```

```
## 23289.93 [m]
```

Buffer - 100m

```sql
SELECT ST_Buffer(ST_Union(geom), 100) AS geom_buf
FROM palar
```

```
palar |>
  st_union() |>
  st_buffer(100)
```

Area

```
SELECT ST_Area(ST_Buffer(ST_Union(geom), 100)) AS area
FROM palar
```

```
palar |>
  st_union() |>
  st_buffer(100) |>
  st_area()
```

```
## 4615553 [m^2]
```

Convex Hull

```sql
SELECT ST_ConvexHull(geom) AS geom
FROM palar
```

```
palar |>
  st_union() |>
  st_convex_hull()
```

Projections

```
SELECT ST_SRID(geom)
FROM palar
LIMIT 1
```

```
st_crs(palar) # 3035
```

Transform

```
CREATE TABLE palar2 AS
  SELECT fid, ST_Transform(geom, 4326) geom -- EPSG for WGS84
  FROM palar
```

https://epsg.io/4326

Intersection

- Aim: Intersect 500m River Buffer with CORINE - LULC data

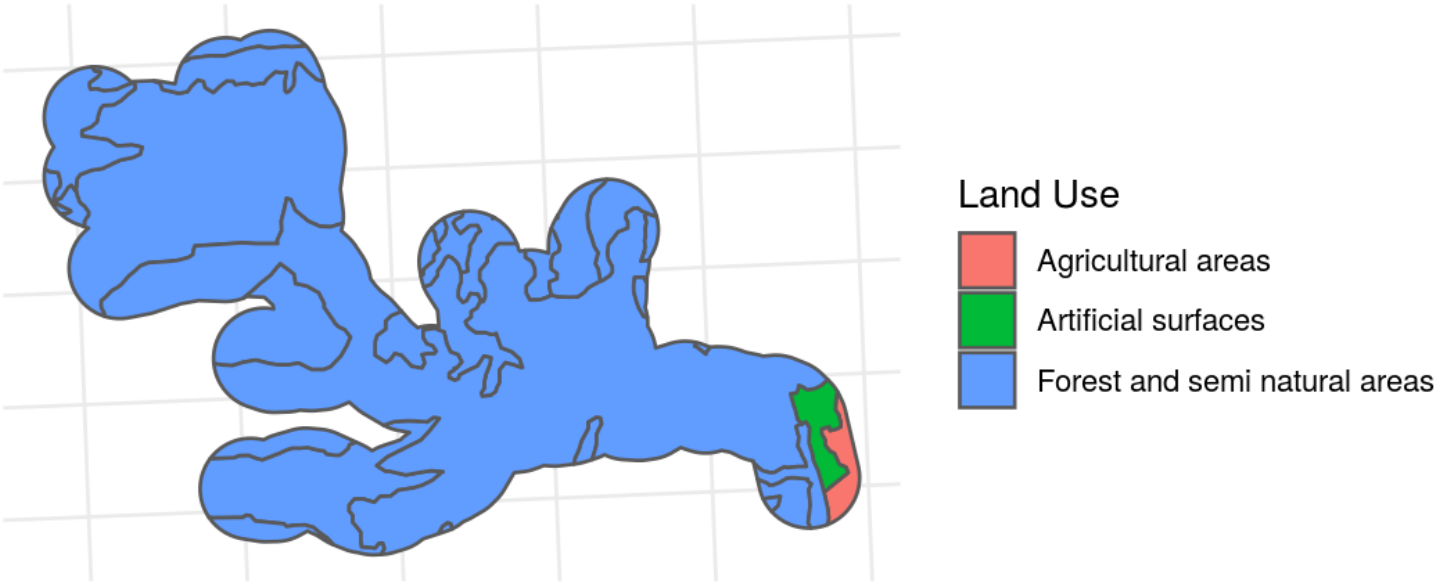
Intersection

```
SELECT
  cor.code_18, cor.label,
  ST_Intersection(ST_Buffer(riv.geom, 500), cor.geom) geom
FROM
  palar riv,
  corine cor
WHERE ST_DWithin(riv.geom, cor.geom, 500)
```

```
palar_buf = palar |>
  st_union() |>
  st_buffer(500)
corine |>
  st_intersection(palar_buf)

st_intersection(corine, st_buffer(st_union(palar), 500))
```

Intersection



Aggregate

```
WITH tmp AS (
  SELECT
    cor.code_18, cor.label,
    ST_Intersection(ST_Buffer(riv.geom, 500), cor.geom) geom
  FROM
    palar riv,
    corine cor
  WHERE ST_DWithin(riv.geom, cor.geom, 500)
)
SELECT
  label, SUM(ST_Area(geom)) AS area
FROM tmp
GROUP BY label
```

```
palar_lulc = palar_int |>
  mutate(area = st_area(palar_int)) |>
  group_by(label) |>
  summarise(area = sum(area))
```

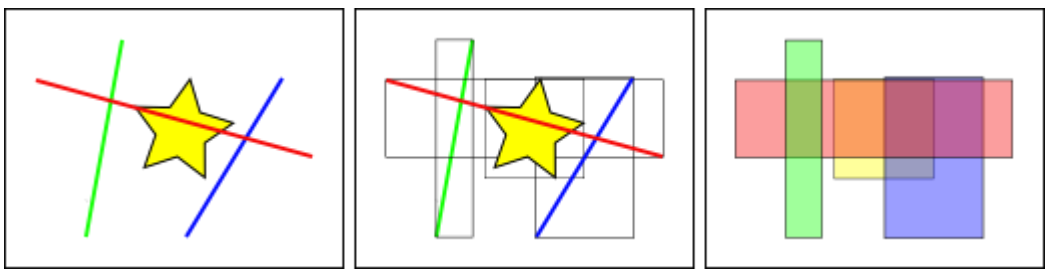
Aggregate

label	area
Agricultural areas	230742.2 [m^2]
Artificial surfaces	283242.3 [m^2]
Forest and semi natural areas	19373840.1 [m^2]

Idexing

Index

- Extremely important for performance!
- Different Indices for different data types
  - PRIMARY KEY
  - BTREE
  - **GIST** - Geographic Data



http://postgis.net/workshops/postgis-intro/indexing.html

Index

```
CREATE INDEX corine_label_btree_idx ON corine USING BTREE (label);
CREATE INDEX palar_geom_gist_idx ON palar USING GIST (geom);
```

Resources

- R sf cheatsheet

https://raw.githubusercontent.com/rstudio/cheatsheets/main/sf.pdf

- Gentle Introduction to PostGIS

https://medium.com/innovation-and-technology/part-1-postgis-at-the-city-of-boston-9476293d71c2

https://medium.com/@paylakatel/part-2-postgis-at-the-city-of-boston-711cf30cf1f3

https://medium.com/@paylakatel/part-3-postgis-at-the-city-of-boston-98b83b0d1503

Slides

- OLAT
- https://andschar.github.io/teaching/PostGIS-intro.html

Made with

- https://github.com/rstudio/rmarkdown
- https://github.com/yihui/knitr
- https://github.com/yihui/xaringan

Introduction to Git & GitHub

Thank you for your attention!

Material: https://andschar.github.io/teaching

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