

A map of British Columbia, Canada, with a reddish-brown color overlay. The map shows the coastline and major rivers. The text is overlaid on the map.

Geographic Data Science in R using bcmmaps

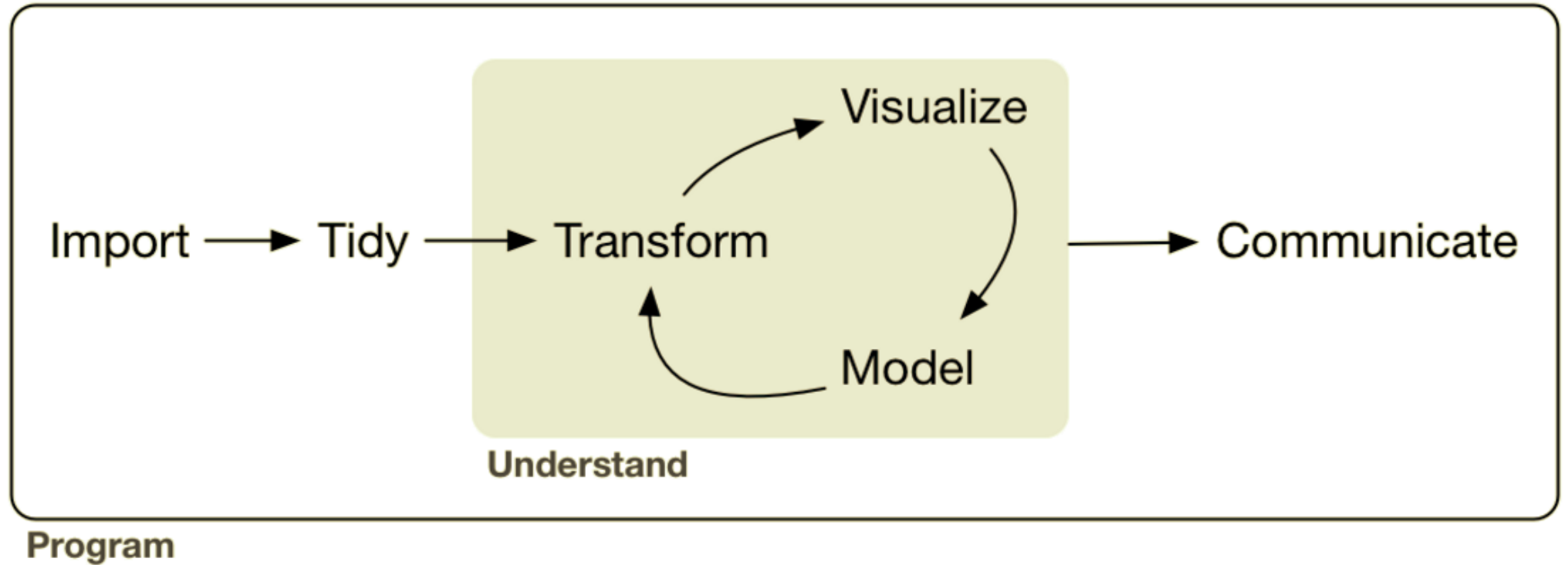
bcgov useR Day 2018

Andy Teucher

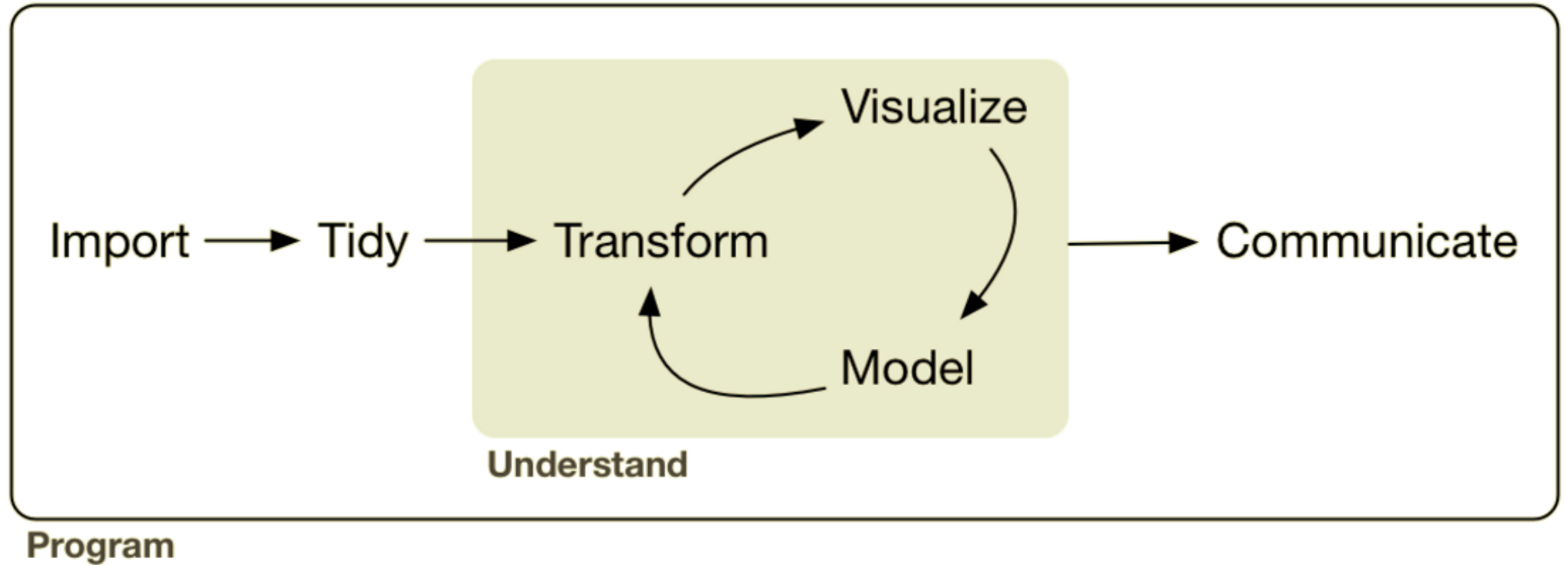
2018/09/11



Data Science



Geographical Data Science



Geographic Information Systems (GIS) VS Geographic Data Science (GDS)¹

Attribute	GIS	GDS
Home disciplines	Geography	Geography, Computing, Statistics
Software focus	Graphical User Interface	Code
Reproducibility	Minimal	Maximal

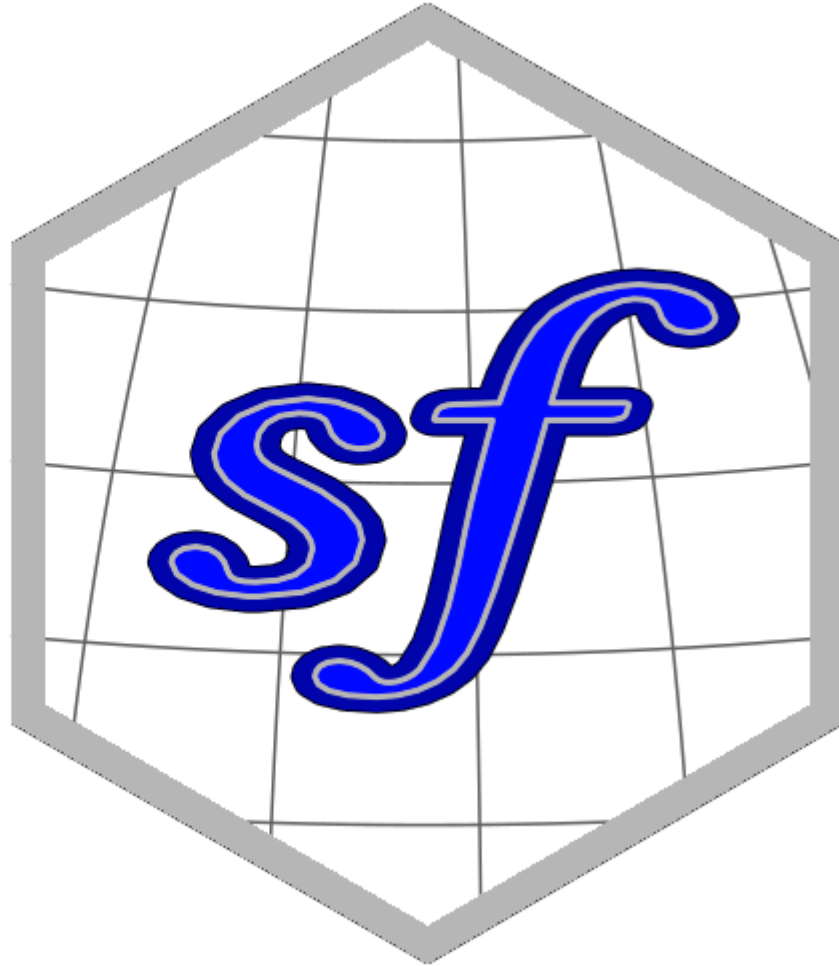
[1] Lovelace, Nowosad, and Muenchow: Geocomputation with R (Table 1.1)



sp

rgdal

rgeos



Ski Resorts

109 views (11 recent)

Published by the [Ministry of Forests, Lands, Natural Resource Operations and Rural Development - GeoBC](#)
Licensed under [Open Government License - British Columbia](#)

Ski Resorts is a point dataset identifying the location of ski resorts in British Columbia.

[alpine ski](#)[sites registry](#)[ski hill](#)[skiing and snowboard...](#)**Geographic
Dataset****Natural
Resources****society**

Data and Resources

**ArcView Shape** *(from Geographic Warehouse)*[Explore](#)**CSV** *(from Geographic Warehouse)*[Explore](#)**ESRI File Geodatabase** *(from Geographic Warehouse)*[Explore](#)**GeoJSON** *(from Geographic Warehouse)*[Explore](#)**WMS getCapabilities request**

For use in viewers such as ESRI tools Click here for information on how to...

[Explore](#)**KML Network Link**

For use in viewers such as Google Earth Click here for information on how...

[Explore](#)

Read data with `st_read()` or `read_sf()`

```
library(sf)
ski_resorts <- read_sf("data/GSR_SKI_RESORTS_SV.geojson")
ski_resorts
```

```
## Simple feature collection with 38 features and 2 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: -128.9534 ymin: 49.06925 xmax: -114.938 ymax: 56.00973
## epsg (SRID):    4326
## proj4string:     +proj=longlat +datum=WGS84 +no_defs
## # A tibble: 38 x 3
##   FACILITY_NAME      MAILING_ADDRESS      geometry
##   <chr>             <chr>             <POINT [°]>
## 1 Clearwater Ski Hill 566 Dunn Lake Rd, Clearwat... (-120.0258 51.63682)
## 2 Cypress Bowl      6000 Cypress Bowl Rd, West... (-123.2022 49.39569)
## 3 Tabor Mountain Ski... 17875 Prince George Hwy 16... (-122.4531 53.9432)
## 4 Blackcomb         4545 Blackcomb Way, Whistl... (-122.9486 50.11492)
## 5 Crystal Mountain R... Powder King, BC          (-119.7106 49.88107)
## 6 Kimberley Ski & Su... Kimberley, BC           (-116.0048 49.68836)
## 7 Shames Mountain   4544 Lakelse Ave, Terrace,... (-128.9534 54.48447)
## 8 Wapiti Ski Club    1000 Natal Rd, Elkford, BC   (-114.938 50.02169)
## 9 Red Mountain Resort 4300 Red Mountain Rd, Ross... (-117.8194 49.10238)
## 10 Big White Ski Reso 5340 Big White Rd, Big Whi... (-118.9286 49.72667)
```

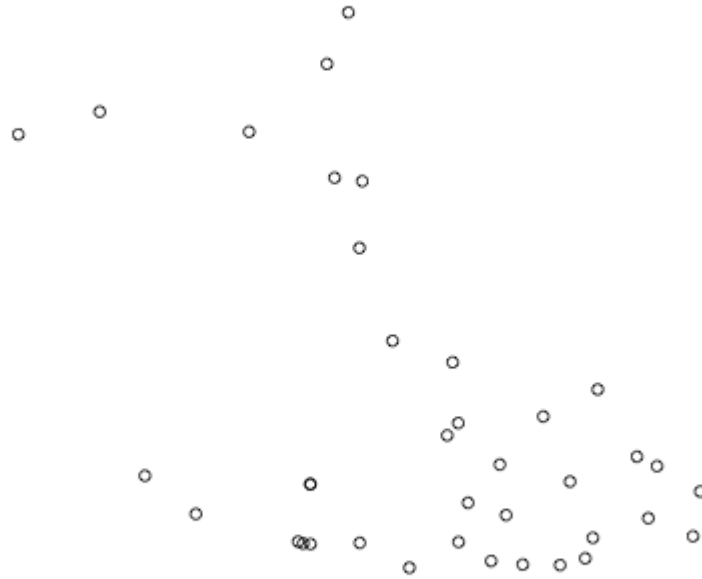
plotting sf objects

```
plot(ski_resorts)
```



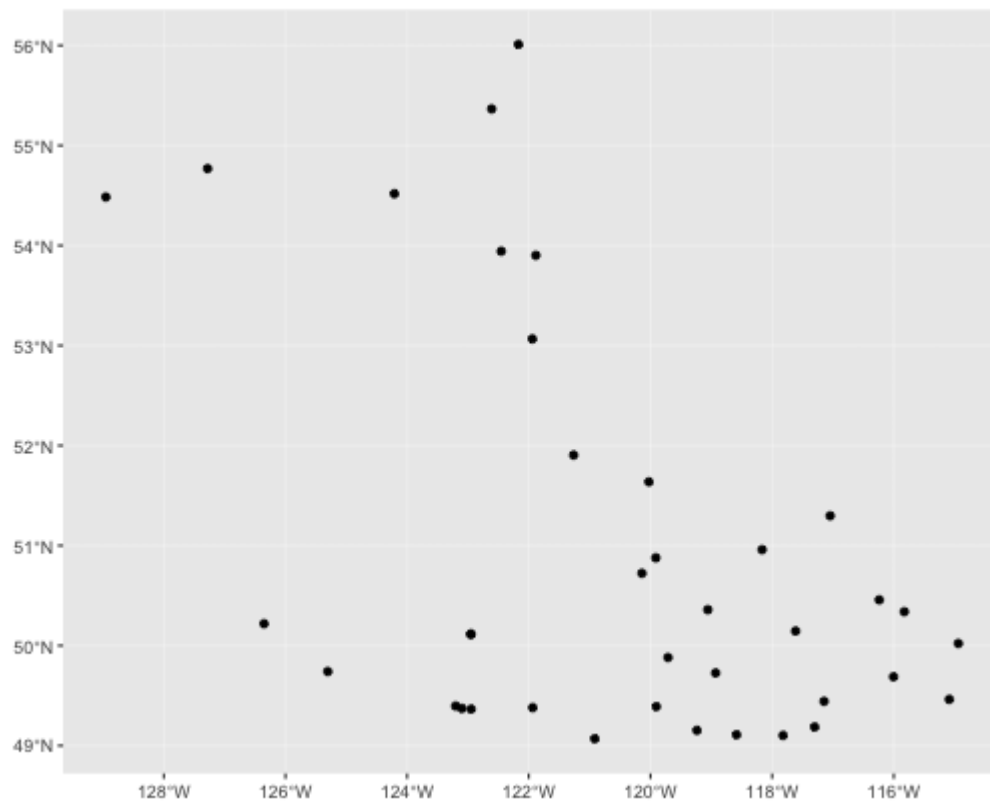
plotting sf objects

```
plot(st_geometry(ski_resorts))
```



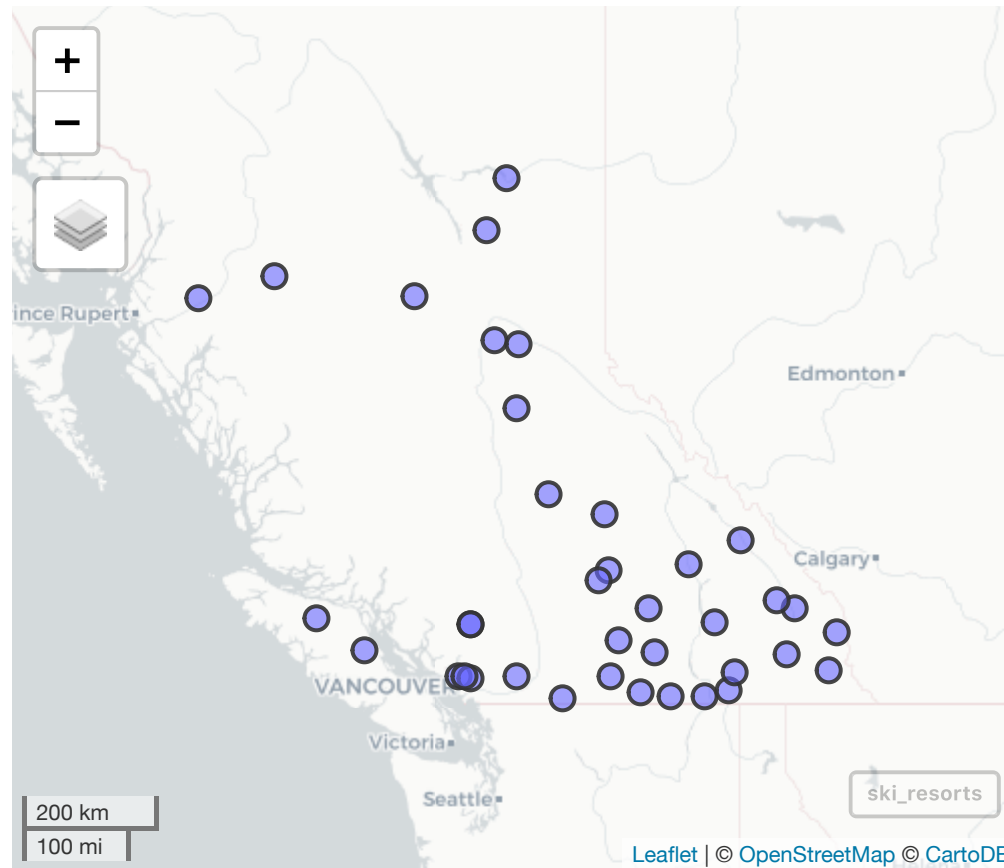
plotting sf objects with ggplot2

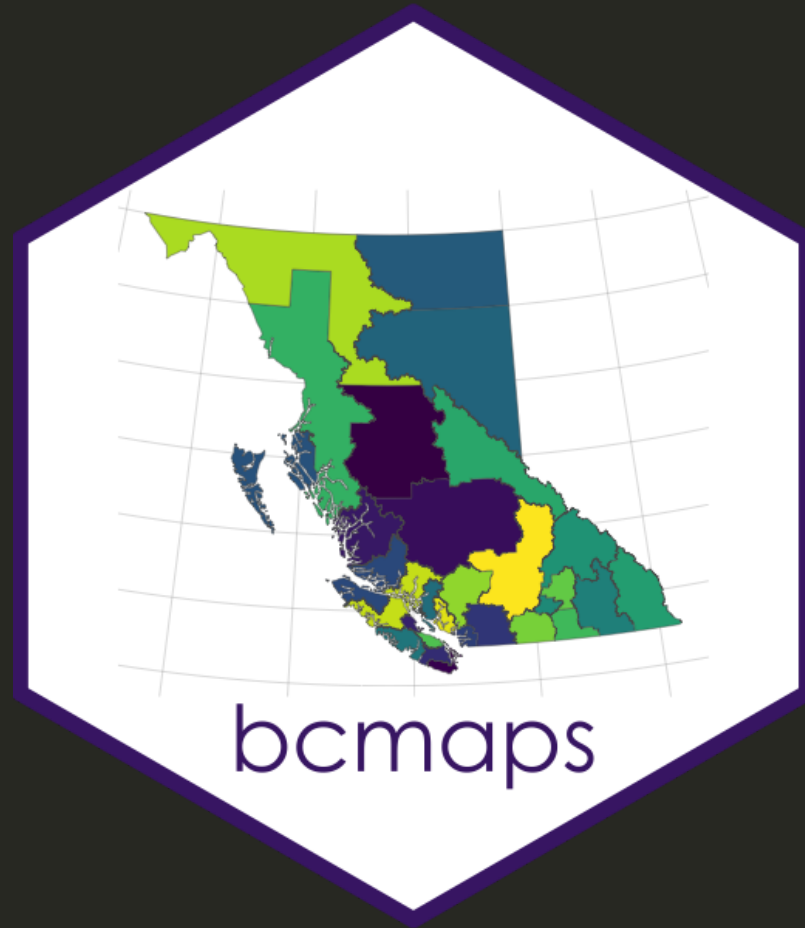
```
library(ggplot2)
ggplot(ski_resorts) +
  geom_sf()
```



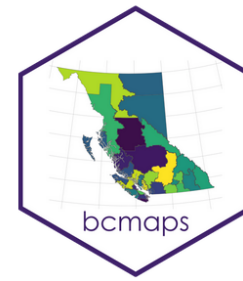
Interactive exploration with **mapview**

```
library(mapview)  
mapview(ski_resorts)
```





bcmaps



🔗 Version 0.17.1.9000

BCDevExchange Delivery license Apache 2.0 build failing

CRAN 0.17.1 downloads 429/month

Overview

An [R](#) package of spatial map layers for British Columbia.

Features

Provides access to various spatial layers of British Columbia, such as administrative boundaries, natural resource management boundaries, watercourses etc. All layers are available in the [BC Albers](#) projection, which is the B.C. Government standard as `sf` or `Spatial` objects.

Layers are stored in the [bcmaps.rdata](#) package and loaded by this package, following the strategy recommended by [Anderson and Eddelbuettel](#).

Installation

You can install `bcmaps` from CRAN:

```
install.packages("bcmaps")
```

<https://github.com/bcgov/bcmaps>

bcmeps layers

```
# install.packages("bcmeps")
library(bcmeps)
available_layers()
```

```
## # A tibble: 22 x 4
##   layer_name  title                                shortcut_functi... local
##   * <chr>      <chr>                                <lgl>          <lgl>
## 1 airzones    British Columbia Air Zones             TRUE           TRUE
## 2 bc_bound    BC Boundary                             TRUE           TRUE
## 3 bc_bound_hr... BC Boundary - High Resolution           TRUE           TRUE
## 4 bc_cities   BC Major Cities Points 1:2,000,000... TRUE           TRUE
## 5 bc_neighbou... Boundary of British Columbia, prov... TRUE           TRUE
## 6 ecoprovinces British Columbia Ecoprovinces          TRUE           TRUE
## 7 ecoregions  British Columbia Ecoregions            TRUE           TRUE
## 8 ecosections British Columbia Ecosections           TRUE           TRUE
## 9 gw_aquifers British Columbia's developed groun... TRUE           TRUE
## 10 hydrozones  Hydrologic Zone Boundaries of Brit... TRUE           TRUE
## # ... with 12 more rows
##
## -----
## Layers with a value of TRUE in the 'shortcut_function' column can be accessed
## with a function with the same name as the layer (e.g., `bc_bound()`),
```


	layer_name	title
1	airzones	British Columbia Air Zones
2	bc_bound	BC Boundary
3	bc_bound_hres	BC Boundary - High Resolution
4	bc_cities	BC Major Cities Points 1:2,000,000 (Digital Baseline Mapping)
5	bc_neighbours	Boundary of British Columbia, provinces/states and the portion of the Pacific Ocean that borders British Columbia
6	ecoprovinces	British Columbia Ecoprovinces
7	ecoregions	British Columbia Ecoregions
8	ecosections	British Columbia Ecosections
9	gw_aquifers	British Columbia's developed ground water aquifers
10	hydrozones	Hydrologic Zone Boundaries of British Columbia
11	municipalities	British Columbia Municipalities

Showing 1 to 11 of 22 entries

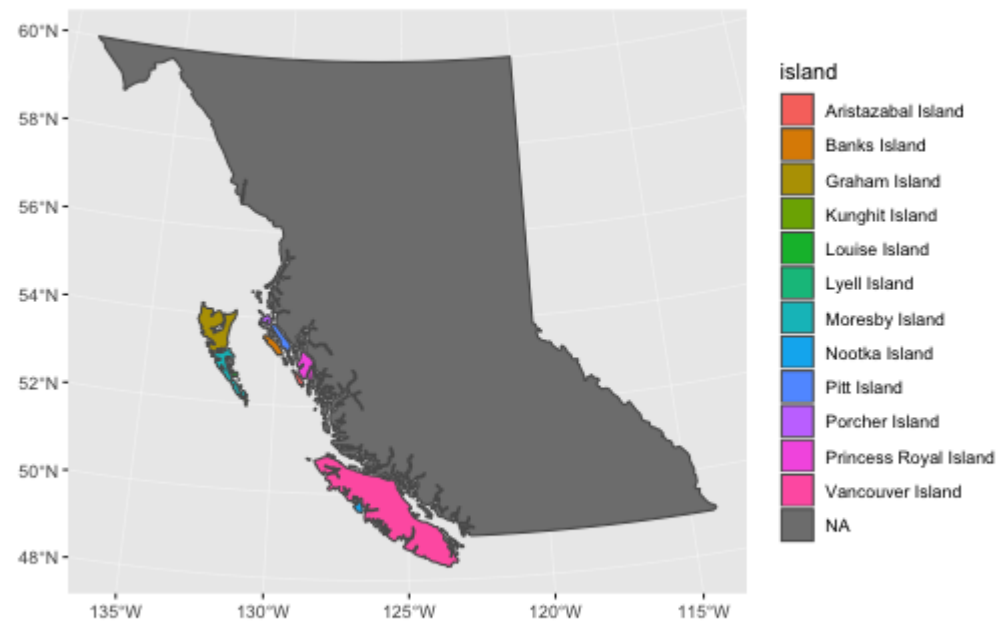
Previous

1

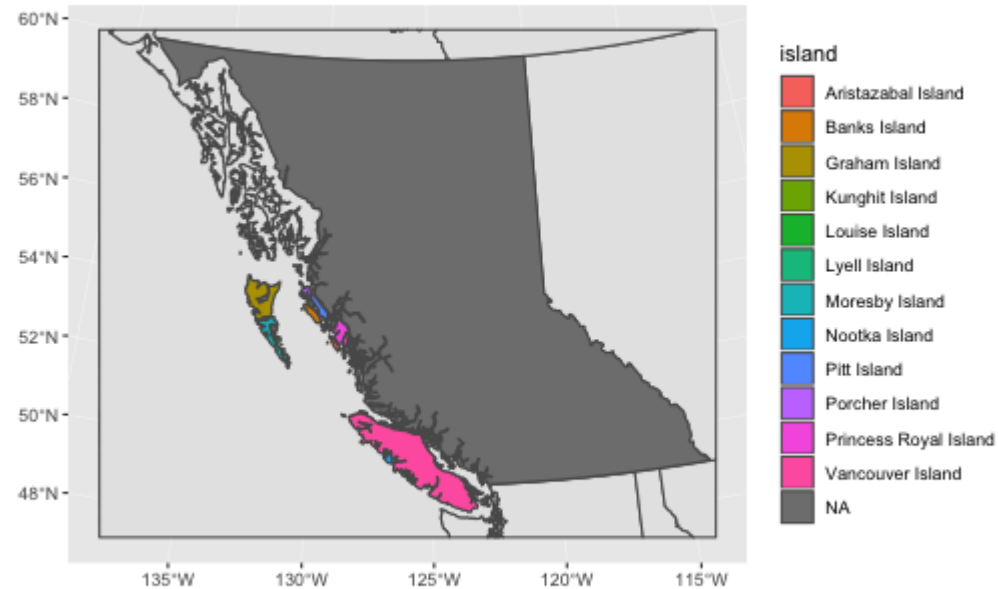
2

Next

```
bc <- bc_bound()
ggplot() +
  geom_sf(data = bc, aes(fill = island))
```



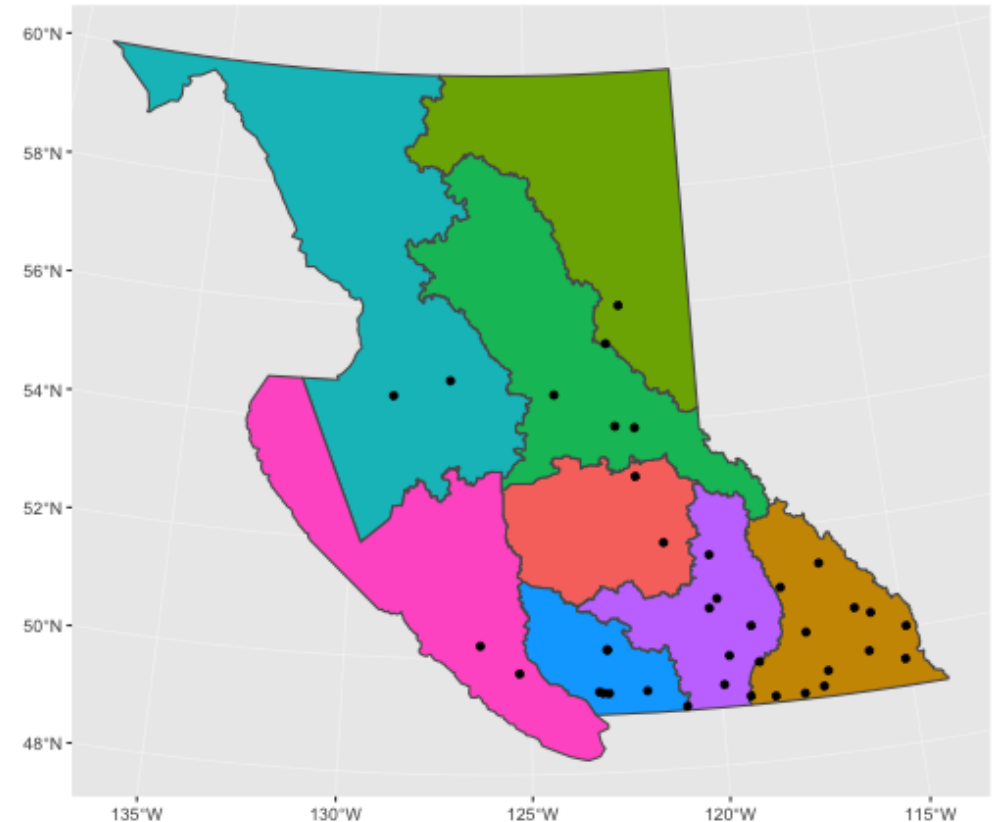
```
bc <- bc_bound()
neighbours <- bc_neighbours()
ggplot() +
  geom_sf(data = neighbours) +
  geom_sf(data = bc, aes(fill = island))
```



Something more interesting

Let's say we want to find the number of ski resorts in each natural resource region. Let's plot it first

```
nr_reg <- nr_regions() %>%  
  select(REGION_NAME)  
  
ggplot() +  
  geom_sf(data = nr_reg,  
          aes(fill = REGION_NAME)) +  
  geom_sf(data = ski_resorts) +  
  theme(legend.position = "none")
```



sf::st_intersection()

Intersect the ski resorts points with the polygons of natural resource regions to get the attributes of the underlying NR region for each point

```
st_intersection(ski_resorts, nr_reg)
```

sf::st_intersection()

Intersect the ski resorts points with the polygons of natural resource regions to get the attributes of the underlying NR region for each point

```
st_intersection(ski_resorts, nr_reg)
```

```
## Error in geos_op2_geom("intersection", x, y): st_crs(x) == st_crs(y) is not TRUE
```

Projections and Coordinate Reference Systems:

- Projections try to transform the earth from its spherical shape (3D) to a planar shape (2D) so that maps can be made on flat layers.
- A Coordinate reference system (CRS) defines how the two-dimensional, projected map is related to real locations on the earth using coordinates.

```
st_crs(ski_resorts)
```

```
## Coordinate Reference System:  
##   EPSG: 4326  
##   proj4string: "+proj=longlat +datum=WGS84 +no_defs"
```

```
st_crs(nr_reg)
```

```
## Coordinate Reference System:  
##   EPSG: 3005  
##   proj4string: "+proj=aea +lat_1=50 +lat_2=58.5 +lat_0=45 +lon_0=-126 +x_0=1000000 +y_0=0 +ellipsoid=GRS80 +units=m +no_defs"
```

sf::st_transform()

```
ski_resorts_bc_albers <- st_transform(ski_resorts, 3005)  
st_crs(ski_resorts_bc_albers, nr_reg)
```

```
## Coordinate Reference System:  
##   EPSG: 3005  
##   proj4string: "+proj=aea +lat_1=50 +lat_2=58.5 +lat_0=45 +lon_0=-126 +x_0=1000000 +y_0=0 +ellps=GRS80 +units=m +no_defs"
```


bcmaps::transform_bc_albers()

```
ski_resorts_bc_albers <- transform_bc_albers(ski_resorts)  
st_crs(ski_resorts_bc_albers, nr_reg)
```

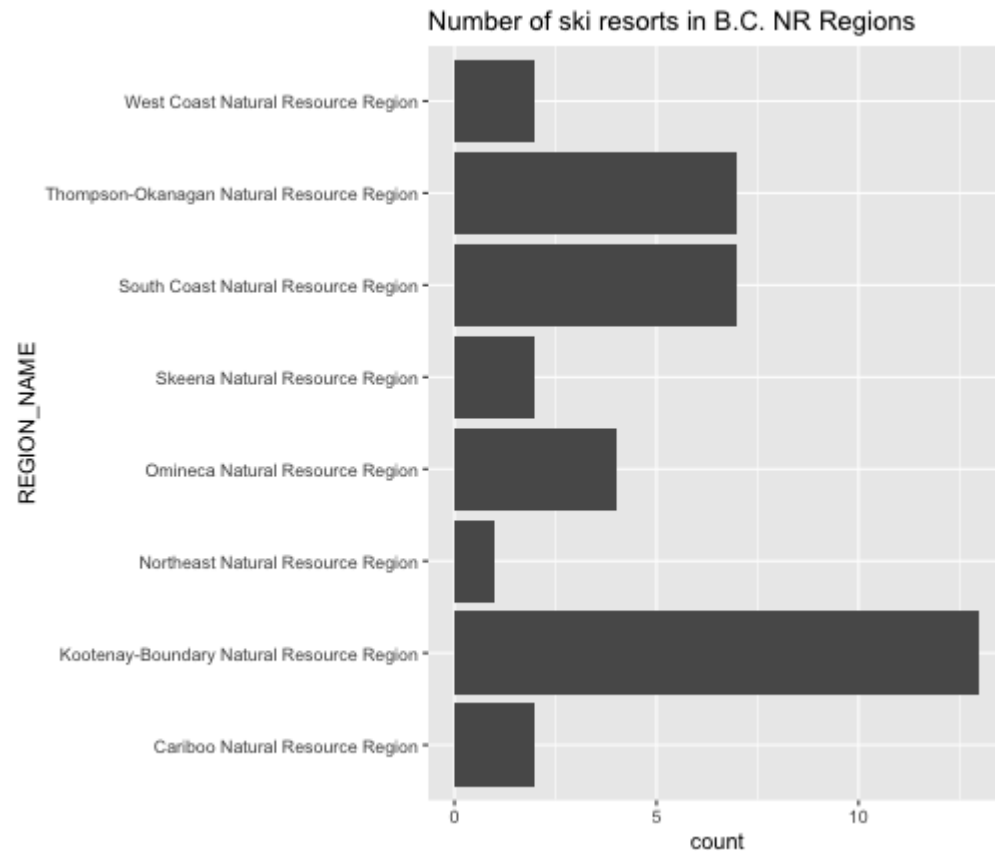
```
## Coordinate Reference System:  
##   EPSG: 3005  
##   proj4string: "+proj=aea +lat_1=50 +lat_2=58.5 +lat_0=45 +lon_0=-126 +x_0=1000000 +y_0=0 +ellipsoid=GRS80"
```

sf::st_intersection()

```
resorts_reg <- st_intersection(ski_resorts_bc_albers, nr_reg)
resorts_reg
```

```
## Simple feature collection with 38 features and 3 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: 809167.1 ymin: 463675.3 xmax: 1789497 ymax: 1230379
## epsg (SRID):    3005
## proj4string:     +proj=aea +lat_1=50 +lat_2=58.5 +lat_0=45 +lon_0=-126 +x_0=1000000 +y_0=0 +ellps=GRS80
## # A tibble: 38 x 4
##   FACILITY_NAME MAILING_ADDRESS REGION_NAME geometry
##   <chr>         <chr>         <chr>         <POINT [m]>
## 1 Troll Resort  7271 Barkerville... Cariboo Natu... (1271211 903164.3)
## 2 Mt Timothy Sk... 318 Birch Pl, Fo... Cariboo Natu... (1325236 776780.1)
## 3 Kimberley Ski... Kimberley, BC      Kootenay-Bou... (1719114 569979.2)
## 4 Wapiti Ski Cl... 1000 Natal Rd, E... Kootenay-Bou... (1789497 618005.4)
## 5 Red Mountain ... 4300 Red Mountai... Kootenay-Bou... (1596715 488521.9)
## 6 Salmo Ski Hill 499 Salmo Ski Hi... Kootenay-Bou... (1633161 502288)
## 7 Whitewater Sk... Whitewater Ski H... Kootenay-Bou... (1640911 531982)
## 8 Fairmont Hot ... 5225 Fairmont Re... Kootenay-Bou... (1721487 643404.5)
## 9 Panorama Moun... 1921 Panorama Dr... Kootenay-Bou... (1690637 652354.8)
## 10 Phoenix Mount... 8000 Phoenix Ski... Kootenay-Bou... (1540949 483122.8)
```

```
ggplot(resorts_reg, aes(x = REGION_NAME)) +  
  geom_bar() +  
  coord_flip() +  
  labs(title = "Number of ski resorts in B.C. NR Regions")
```



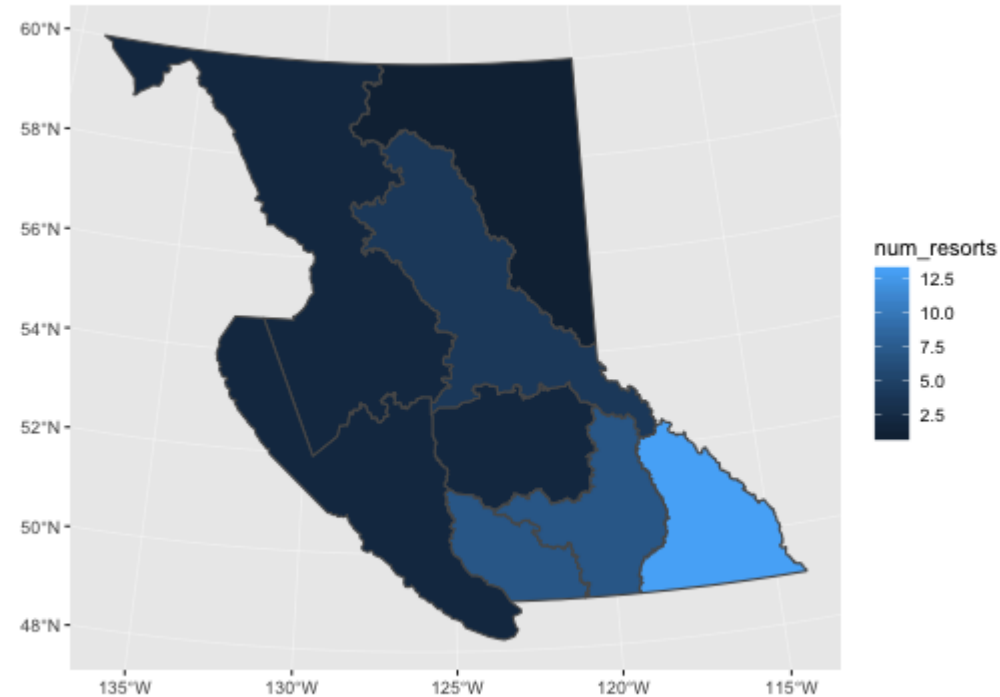
We can go the other way to get the number of ski resorts into each NR region

```
resorts_in_regions <- st_contains(nr_reg, ski_resorts_bc_albers)
resorts_in_regions
```

```
## Sparse geometry binary predicate list of length 8, where the predicate was `contains`
## 1: 18, 33
## 2: 6, 8, 9, 11, 13, 19, 23, 24, 26, 28, ...
## 3: 15
## 4: 3, 27, 30, 38
## 5: 7, 21
## 6: 2, 4, 12, 14, 20, 25, 31
## 7: 1, 5, 10, 16, 34, 35, 36
## 8: 17, 22
```

Create a choropleth map showing the regions with the most ski resorts

```
resorts_in_regions <- st_covers(nr_reg, ski_resorts_bc_albers)  
nr_reg$num_resorts <- lengths(resorts_in_regions)  
ggplot(nr_reg) +  
  geom_sf(aes(fill = num_resorts))
```



Resources

Geocomputation with R

Robin Lovelace, Jakub Nowosad, Jannes Muenchow

2018-10-05

Welcome

This is the online home of *Geocomputation with R*, a book on geographic data analysis, visualization and modeling. It is published online here and by CRC Press in the [R Series](#).

Inspired by [bookdown](#) and the Free and Open Source Software for Geospatial ([FOSS4G](#)) movement, this book is open source. This ensures its contents are reproducible and publicly accessible or people worldwide.

Source code for this presentation available [here](#)

Made with [xaringan](#)

<https://geocompr.robinlovelace.net/>

<https://github.com/bcgov/bcmaps>

<http://r4ds.had.co.nz/>

<http://r-spatial.org/>

