Mining Spatial Data

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Contents

Raster = data gambar

```
# load library
library(sp)
```

```
## Warning: package 'sp' was built under R version 4.4.2
```

```
library(raster)
```

```
## Warning: package 'raster' was built under R version 4.4.2
```

```r
# load data
load("./Data/wst.RData")
head(wst)
```

```
##    longitude latitude name precip
## 1     -116.7     45.3    A    721
## 2     -120.4     42.6    B     19
## 3     -116.7     38.9    C     52
## 4     -113.5     42.1    D    188
## 5     -115.5     35.7    E    749
## 6     -120.8     38.9    F      8
```

```r
class(wst)
```

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

Define spatial data

```r
lonlat1 = cbind(wst$longitude, wst$latitude)
pts = SpatialPoints(lonlat1)
pts
```

```
## class       : SpatialPoints
## features    : 10
## extent      : -120.8, -110.7, 35.7, 45.3  (xmin, xmax, ymin, ymax)
## crs         : NA
```

Define Coordinate Reference System (CRS) in spatial data

```r
# define crs
crdref = CRS('+proj=longlat +datum=WGS84')
pts = SpatialPoints(lonlat1, proj4string = crdref)
pts
```

```
## class       : SpatialPoints
## features    : 10
## extent      : -120.8, -110.7, 35.7, 45.3  (xmin, xmax, ymin, ymax)
## crs         : +proj=longlat +datum=WGS84 +no_defs
```

Insert variable information of interest

```r
df = data.frame(ID=wst$name, precip = wst$precip)
ptsdf = SpatialPointsDataFrame(pts, data = df)
plot(ptsdf, axes = T)
```
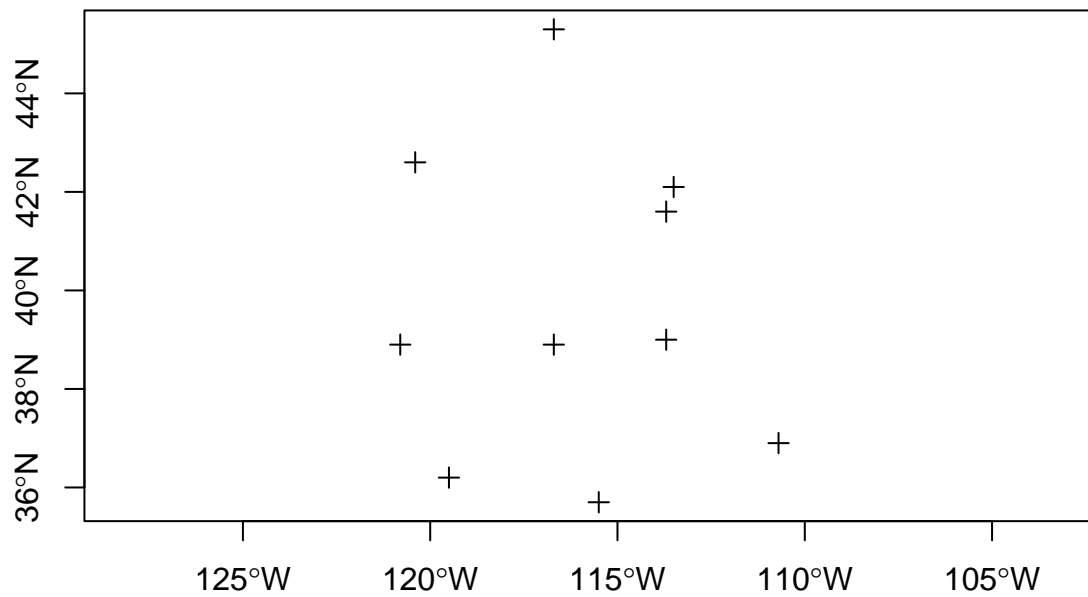
For clearer view :
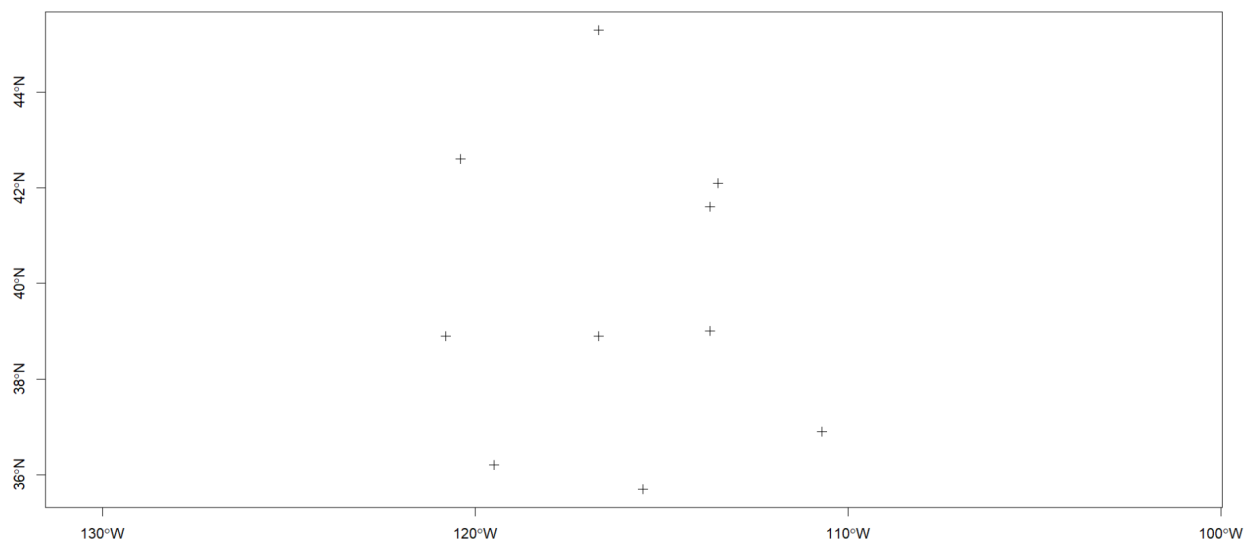

```r
# look at the details of the data
showDefault(ptsdf)
```

```
## An object of class "SpatialPointsDataFrame"
## Slot "data":
##    ID precip
```

```
## 1    A    721
## 2    B     19
## 3    C     52
## 4    D    188
## 5    E    749
## 6    F      8
## 7    G    725
## 8    H    843
## 9    I    289
## 10   J    249
##
## Slot "coords.nrs":
## numeric(0)
##
## Slot "coords":
##        coords.x1 coords.x2
##  [1,]     -116.7      45.3
##  [2,]     -120.4      42.6
##  [3,]     -116.7      38.9
##  [4,]     -113.5      42.1
##  [5,]     -115.5      35.7
##  [6,]     -120.8      38.9
##  [7,]     -119.5      36.2
##  [8,]     -113.7      39.0
##  [9,]     -113.7      41.6
## [10,]     -110.7      36.9
##
## Slot "bbox":
##              min    max
## coords.x1 -120.8 -110.7
## coords.x2   35.7   45.3
##
## Slot "proj4string":
## Coordinate Reference System:
## Deprecated Proj.4 representation: +proj=longlat +datum=WGS84 +no_defs
## WKT2 2019 representation:
## GEOGCRS["unknown",
##     DATUM["World Geodetic System 1984",
##         ELLIPSOID["WGS 84",6378137,298.257223563,
##             LENGTHUNIT["metre",1]],
##         ID["EPSG",6326]],
##     PRIMEM["Greenwich",0,
##         ANGLEUNIT["degree",0.0174532925199433],
##         ID["EPSG",8901]],
##     CS[ellipsoidal,2],
##         AXIS["longitude",east,
##             ORDER[1],
##             ANGLEUNIT["degree",0.0174532925199433,
##                 ID["EPSG",9122]]],
##         AXIS["latitude",north,
##             ORDER[2],
##             ANGLEUNIT["degree",0.0174532925199433,
##                 ID["EPSG",9122]]]]
```
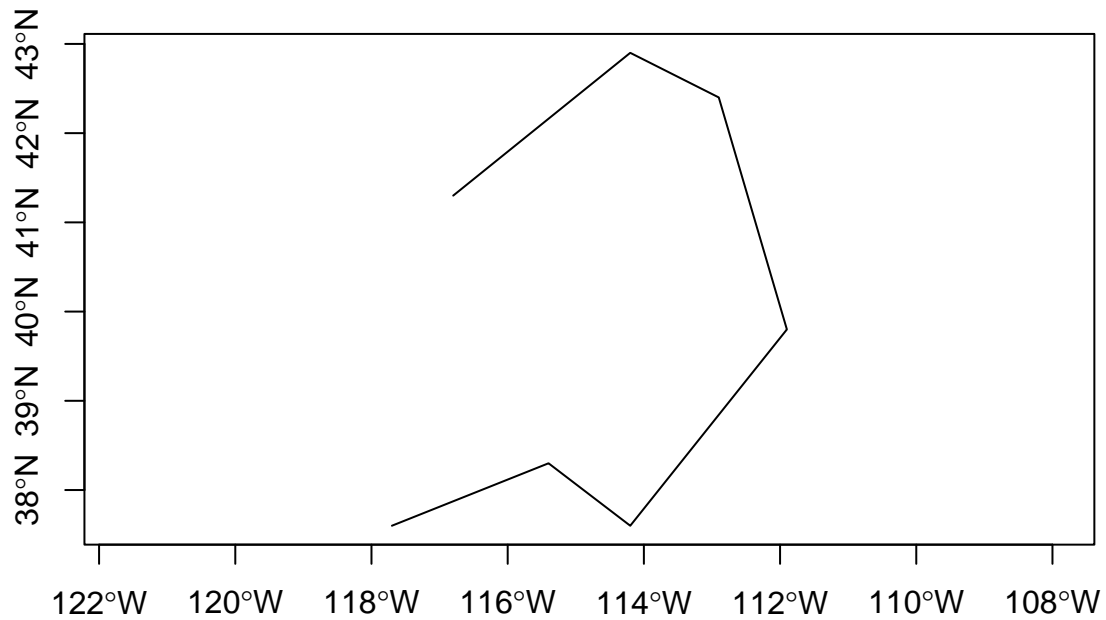
```
# spatial lines
lon = c(-116.8, -114.2, -112.9, -111.9, -114.2, -115.4, -117.7)
lat = c(41.3, 42.9, 42.4, 39.8, 37.6, 38.3, 37.6)
lonlat = cbind(lon, lat)
lns = spLines(lonlat, crs=crdref)
plot(lns, axes = T)
```


Polygon

```
pols = spPolygons(lonlat, crs=crdref)
plot(pols, axes = T)
```
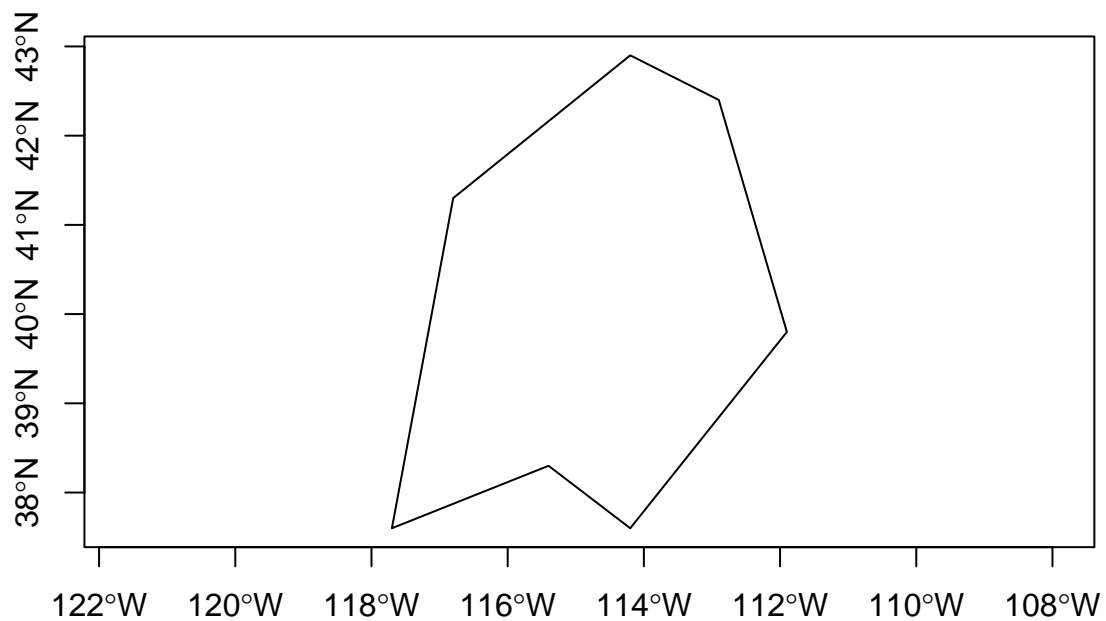
Raster

```r
r = raster(ncol = 20, nrow=20, xmx=-80, xmn=-150, ymn=20, ymx=60)

x = rexp(ncell(r))

values(r) = x

showDefault(r)
```

```
## An object of class "RasterLayer"
## Slot "file":
## An object of class ".RasterFile"
## Slot "name":
## [1] ""
##
## Slot "datanotation":
## [1] "FLT4S"
##
## Slot "byteorder":
## [1] "little"
##
## Slot "nodatavalue":
```

```
## [1] -Inf
##
## Slot "NAchanged":
## [1] FALSE
##
## Slot "nbands":
## [1] 1
##
## Slot "bandorder":
## [1] "BIL"
##
## Slot "offset":
## [1] 0
##
## Slot "toptobottom":
## [1] TRUE
##
## Slot "blockrows":
## [1] 0
##
## Slot "blockcols":
## [1] 0
##
## Slot "driver":
## [1] ""
##
## Slot "open":
## [1] FALSE
##
##
## Slot "data":
## An object of class ".SingleLayerData"
## Slot "values":
##    [1] 1.105995480 1.798956068 0.524359076 1.575685935 1.916825802 0.215358826
##    [7] 1.709578011 0.110983155 0.142087759 0.215709285 4.358379800 0.353947135
##   [13] 1.153787440 0.155285059 2.023904037 0.223515479 0.930913338 2.189391704
##   [19] 0.548338315 0.060074399 1.502173066 2.153337452 0.052397314 1.515275823
##   [25] 2.135714402 5.104499250 1.861105110 0.385086230 0.216484241 0.414554823
##   [31] 0.400709287 1.664510967 1.189689036 0.341687944 1.326392048 0.421340495
##   [37] 0.096838000 0.395433164 2.244523360 0.069818682 0.527006101 1.048334060
##   [43] 0.532396448 0.448098213 2.600160057 2.166616725 0.299207054 0.665409615
##   [49] 0.894278527 0.193333529 0.323305524 0.094189729 1.625569653 1.809831748
##   [55] 0.773582951 0.100981787 1.645095890 3.617263814 3.511991789 2.207470557
##   [61] 6.135589108 0.873529353 0.526878973 0.753289978 0.412384404 0.591358841
##   [67] 0.248863516 2.621565064 0.178900128 1.956595410 0.778109801 1.143389559
##   [73] 0.884273021 0.670125147 1.855436399 0.325160328 0.095320133 0.383489397
##   [79] 1.549419941 0.271205638 0.277635393 0.445191493 0.244019285 1.507045181
##   [85] 1.404536437 0.781212282 0.120091561 1.172249542 1.279820662 0.199213891
##   [91] 7.163724880 2.425210201 0.365802627 0.588046380 0.149284397 0.657775599
##   [97] 2.527626709 1.198347824 1.280526900 1.074314015 2.133687945 0.496862681
##  [103] 0.095814636 0.658345930 0.455160667 2.196466144 0.525917101 1.757486617
##  [109] 0.278814157 1.414096184 3.170553453 0.045305151 0.834310262 0.607158900
##  [115] 1.803118893 2.273202958 1.929346822 0.069053652 0.090971166 0.303911007
##  [121] 0.865587546 0.669678144 0.330257171 0.649542650 1.425309405 3.157731756
```

```
## [127] 0.062970593 0.278275146 0.858391106 0.528942137 0.253839541 0.307544816
## [133] 0.140257451 1.417835506 0.035883069 0.127470069 0.518917027 0.781922752
## [139] 0.742245050 0.537977201 0.707774542 0.477638514 6.069197520 0.454714055
## [145] 0.669909169 1.639757607 0.362342908 0.816391556 0.459171109 1.891380433
## [151] 0.816462628 0.708862711 2.037777351 0.970398125 2.567855136 0.453057011
## [157] 0.910442097 1.334446891 0.048827024 1.042383615 1.255987171 0.689698923
## [163] 1.146973179 0.059453643 0.936402624 0.387002546 1.060724490 0.210105093
## [169] 0.067039174 0.778041404 1.448933780 0.143593330 0.570215009 0.707161855
## [175] 0.433406537 1.394444244 1.696777433 1.428559419 0.763368694 0.408477439
## [181] 0.306386732 0.798680671 0.877294787 1.208576685 0.343626968 0.308908916
## [187] 0.291163926 0.918222985 1.750194212 1.943862170 0.082861083 0.934419708
## [193] 1.178470182 0.469898586 0.459441859 1.297370866 1.602893269 0.076108486
## [199] 1.010859152 0.156342539 1.319775003 1.085836909 4.831222642 0.411634073
## [205] 0.202117605 0.184147198 0.337037731 1.431062639 1.289494525 0.986301727
## [211] 0.798350722 0.543489659 1.818339366 1.191844914 0.665268100 0.004959437
## [217] 0.118988305 3.235004723 2.726831915 3.722899845 1.369098274 0.044262848
## [223] 1.218667599 0.459538467 0.160655307 0.345708183 0.413973057 0.028971198
## [229] 0.781534291 0.843624549 2.210879626 0.685947885 1.947950028 1.423183646
## [235] 1.521892019 1.587143821 0.054973369 0.747846570 0.562218425 1.916217351
## [241] 1.995666677 0.973053918 0.402064336 0.218263755 1.059594180 0.314443766
## [247] 0.937712642 1.636924709 0.097240509 1.467007389 0.862567460 2.378913458
## [253] 0.056659289 1.253723750 0.725446851 3.757200127 0.644327085 2.216446392
## [259] 0.771582182 1.271767624 1.192735654 0.289507997 0.244978228 0.389417042
## [265] 0.522652719 0.420984270 1.783520274 1.784565786 3.437665276 0.148709899
## [271] 1.825185977 0.144390990 1.219832005 0.918190261 2.114977902 0.057344964
## [277] 0.383489170 4.960063000 0.073823946 0.829624153 0.068041776 0.847801791
## [283] 0.980361306 0.473661336 0.889089617 0.244505984 3.858040443 0.281508852
## [289] 2.305619237 0.163502404 0.616361088 1.208751443 0.824144193 0.394111761
## [295] 0.354760795 0.611944128 1.653851909 0.481771003 0.329706538 0.495996084
## [301] 0.003330597 1.421165187 0.836187310 0.540251781 1.102906552 0.835509323
## [307] 1.220305685 2.694520453 0.570163330 1.159187205 1.112085750 0.593531695
## [313] 1.197182935 0.258495642 0.443244797 0.647020674 0.220948949 1.485207697
## [319] 0.423345944 0.494490841 1.057904320 0.598992666 1.544766355 0.441853078
## [325] 1.125366289 0.044684348 0.225032056 2.315058002 0.967435881 0.144407357
## [331] 0.838305825 0.569472676 0.468910560 0.471608956 0.912178352 0.014469137
## [337] 0.702793381 0.995318385 2.792437932 1.663814517 1.591357654 0.993435149
## [343] 1.060349232 0.569089911 1.226200932 1.599649714 2.962250210 0.578831541
## [349] 0.096081649 0.858634648 1.623247923 0.842162231 0.270070902 0.850737229
## [355] 0.698842089 0.250025861 0.527100959 0.895730311 0.286841317 0.157653298
## [361] 2.590341879 0.030565958 2.231315186 0.336920974 0.014171461 0.012034807
## [367] 1.014121235 0.152230075 0.134214725 2.976637506 0.946254661 2.267909705
## [373] 1.815827174 1.311253869 0.575979718 0.141566616 3.063748850 0.069067053
## [379] 0.502857352 1.681769688 1.707981341 0.712527316 0.913241849 2.719708124
## [385] 1.151551408 0.977082809 0.476789127 2.116713403 0.129180418 0.396187485
## [391] 0.385497142 0.020749886 1.915192056 0.569100213 1.158892060 0.046582780
## [397] 0.705417598 0.146467282 0.074554713 0.137318476
##
## Slot "offset":
## [1] 0
##
## Slot "gain":
## [1] 1
##
## Slot "inmemory":
```

```
## [1] TRUE
##
## Slot "fromdisk":
## [1] FALSE
##
## Slot "isfactor":
## [1] FALSE
##
## Slot "attributes":
## list()
##
## Slot "haveminmax":
## [1] TRUE
##
## Slot "min":
## [1] 0.003330597
##
## Slot "max":
## [1] 7.163725
##
## Slot "band":
## [1] 1
##
## Slot "unit":
## [1] ""
##
## Slot "names":
## [1] ""
##
##
## Slot "legend":
## An object of class ".RasterLegend"
## Slot "type":
## character(0)
##
## Slot "values":
## logical(0)
##
## Slot "color":
## logical(0)
##
## Slot "names":
## logical(0)
##
## Slot "colortable":
## logical(0)
##
##
## Slot "title":
## character(0)
##
## Slot "extent":
## class      : Extent
## xmin       : -150
```

```
## xmax        : -80
## ymin        : 20
## ymax        : 60
##
## Slot "rotated":
## [1] FALSE
##
## Slot "rotation":
## An object of class ".Rotation"
## Slot "geotrans":
## numeric(0)
##
## Slot "transfun":
## function ()
## NULL
## <bytecode: 0x000002667e81a7b0>
##
##
## Slot "ncols":
## [1] 20
##
## Slot "nrows":
## [1] 20
##
## Slot "crs":
## Coordinate Reference System:
## Deprecated Proj.4 representation: NA
##
## Slot "srs":
## [1] "GEOGCRS[\"unknown\",\n    DATUM[\"World Geodetic System 1984\",\n        ELLIPSOID[\"WGS 84\",63
##
## Slot "history":
## list()
##
## Slot "z":
## list()
```

```r
plot(r)
```
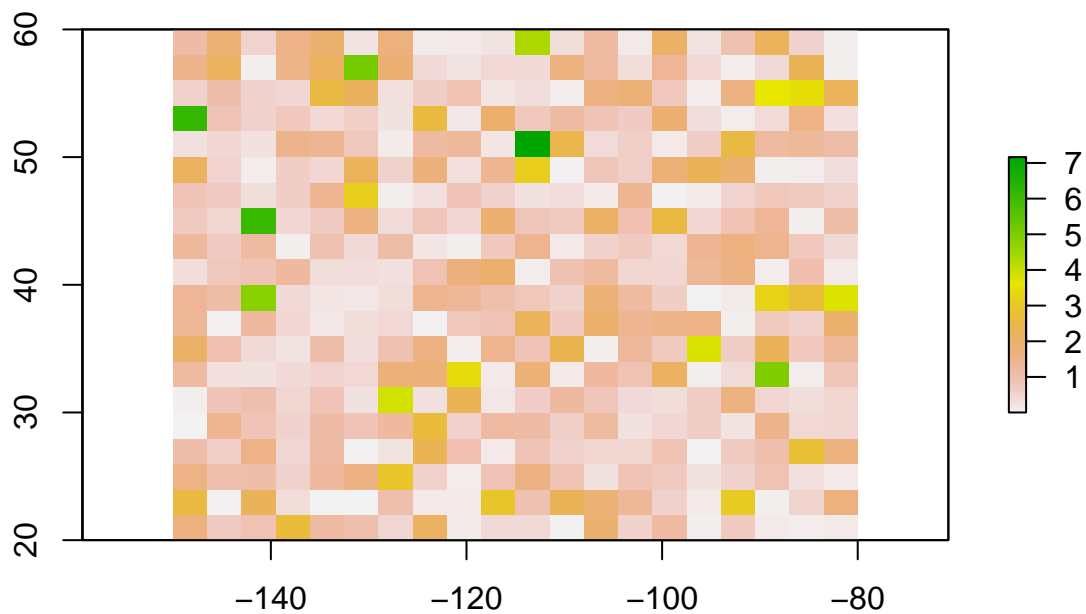
```
r2 = r*r
r3 = sqrt(r)
r4 = 2 * r2 + r3
s = stack(r, r2, r3, r4)
showDefault(s)
```

```
## An object of class "RasterStack"
## Slot "filename":
## [1] ""
##
## Slot "layers":
## [[1]]
## class      : RasterLayer
## dimensions : 20, 20, 400  (nrow, ncol, ncell)
## resolution : 3.5, 2  (x, y)
## extent     : -150, -80, 20, 60  (xmin, xmax, ymin, ymax)
## crs        : +proj=longlat +datum=WGS84 +no_defs
## source     : memory
## names      : layer.1
## values     : 0.003330597, 7.163725  (min, max)
##
##
## [[2]]
## class      : RasterLayer
## dimensions : 20, 20, 400  (nrow, ncol, ncell)
## resolution : 3.5, 2  (x, y)
```

```
## extent      : -150, -80, 20, 60  (xmin, xmax, ymin, ymax)
## crs         : +proj=longlat +datum=WGS84 +no_defs
## source      : memory
## names       : layer.2
## values      : 1.109288e-05, 51.31895  (min, max)
##
##
## [[3]]
## class       : RasterLayer
## dimensions  : 20, 20, 400  (nrow, ncol, ncell)
## resolution  : 3.5, 2  (x, y)
## extent      : -150, -80, 20, 60  (xmin, xmax, ymin, ymax)
## crs         : +proj=longlat +datum=WGS84 +no_defs
## source      : memory
## names       : layer.3
## values      : 0.05771133, 2.676514  (min, max)
##
##
## [[4]]
## class       : RasterLayer
## dimensions  : 20, 20, 400  (nrow, ncol, ncell)
## resolution  : 3.5, 2  (x, y)
## extent      : -150, -80, 20, 60  (xmin, xmax, ymin, ymax)
## crs         : +proj=longlat +datum=WGS84 +no_defs
## source      : memory
## names       : layer.4
## values      : 0.05773351, 105.3144  (min, max)
##
##
##
## Slot "title":
## character(0)
##
## Slot "extent":
## class       : Extent
## xmin        : -150
## xmax        : -80
## ymin        : 20
## ymax        : 60
##
## Slot "rotated":
## [1] FALSE
##
## Slot "rotation":
## An object of class ".Rotation"
## Slot "geotrans":
## numeric(0)
##
## Slot "transfun":
## function ()
## NULL
## <bytecode: 0x000002667ebc2858>
##
##
```

```
## Slot "ncols":
## [1] 20
##
## Slot "nrows":
## [1] 20
##
## Slot "crs":
## Coordinate Reference System:
## Deprecated Proj.4 representation: NA
##
## Slot "srs":
## [1] "GEOGCRS[\"unknown\",\n    DATUM[\"World Geodetic System 1984\",\n        ELLIPSOID[\"WGS 84\",6
##
## Slot "history":
## list()
##
## Slot "z":
## list()
```

```
plot(s)
```


Present data in data frame

```
library(terra)
```

```
## Warning: package 'terra' was built under R version 4.4.2
```

```
## terra 1.8.21
```

```
f = system.file('external/lux.shp', package='raster')
p = shapefile(f) #spatial polygon
plot(p, axes=T)
```
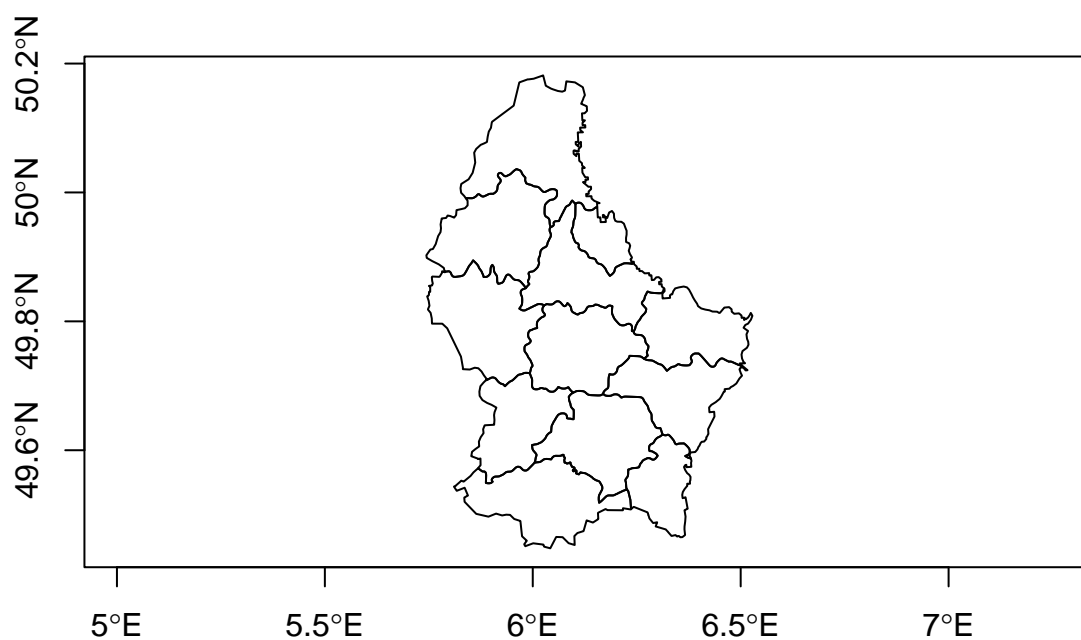


```
d = data.frame(p)
```

```
d
```

```
##    ID_1      NAME_1 ID_2        NAME_2 AREA
## 1     1     Diekirch    1      Clervaux  312
## 2     1     Diekirch    2      Diekirch  218
## 3     1     Diekirch    3       Redange  259
## 4     1     Diekirch    4       Vianden   76
## 5     1     Diekirch    5         Wiltz  263
## 6     2 Grevenmacher    6     Echternach  188
## 7     2 Grevenmacher    7        Remich  129
## 8     2 Grevenmacher   12  Grevenmacher  210
```

```
## 9      3    Luxembourg     8        Capellen  185
## 10     3    Luxembourg     9 Esch-sur-Alzette  251
## 11     3    Luxembourg    10      Luxembourg  237
## 12     3    Luxembourg    11          Mersch  233
```

```r
showDefault(p) # spatial polygons data frame
```

```
## An object of class "SpatialPolygonsDataFrame"
## Slot "data":
##     ID_1         NAME_1 ID_2          NAME_2 AREA
## 1     1       Diekirch    1         Clervaux  312
## 2     1       Diekirch    2         Diekirch  218
## 3     1       Diekirch    3          Redange  259
## 4     1       Diekirch    4          Vianden   76
## 5     1       Diekirch    5           Wiltz  263
## 6     2    Grevenmacher    6       Echternach  188
## 7     2    Grevenmacher    7          Remich  129
## 8     2    Grevenmacher   12     Grevenmacher  210
## 9     3    Luxembourg     8        Capellen  185
## 10     3    Luxembourg     9 Esch-sur-Alzette  251
## 11     3    Luxembourg    10      Luxembourg  237
## 12     3    Luxembourg    11          Mersch  233
##
## Slot "polygons":
## [[1]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]  6.009082 50.070636
##
## Slot "area":
## [1] 0.03921637
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##             x        y
## 1    6.026519 50.17767
## 2    6.031361 50.16563
## 3    6.035646 50.16410
## 4    6.042747 50.16157
## 5    6.043894 50.16116
## 6    6.048243 50.16008
## 7    6.058833 50.15779
## 8    6.060411 50.15745
## 9    6.070838 50.15641
## 10   6.077541 50.15807
## 11   6.080800 50.17240
```

```
## 12   6.101561 50.17081
## 13   6.107108 50.16858
## 14   6.120430 50.16320
## 15   6.124232 50.15381
## 16   6.125362 50.15102
## 17   6.124943 50.15047
## 18   6.122098 50.14677
## 19   6.121018 50.14440
## 20   6.116489 50.13781
## 21   6.116355 50.13762
## 22   6.122279 50.13591
## 23   6.127972 50.13428
## 24   6.129925 50.13377
## 25   6.130520 50.12660
## 26   6.124599 50.12284
## 27   6.118379 50.12276
## 28   6.119270 50.11173
## 29   6.125499 50.11181
## 30   6.119559 50.10805
## 31   6.119860 50.10437
## 32   6.126100 50.10445
## 33   6.126390 50.10077
## 34   6.113909 50.10061
## 35   6.114210 50.09693
## 36   6.120749 50.09333
## 37   6.108259 50.09317
## 38   6.109429 50.07846
## 39   6.103168 50.07839
## 40   6.103457 50.07470
## 41   6.110010 50.07111
## 42   6.109720 50.07478
## 43   6.115680 50.07854
## 44   6.116271 50.07119
## 45   6.110311 50.06743
## 46   6.110498 50.06504
## 47   6.110600 50.06375
## 48   6.104339 50.06368
## 49   6.104257 50.06472
## 50   6.099645 50.06538
## 51   6.098003 50.06456
## 52   6.098370 50.05991
## 53   6.104920 50.05632
## 54   6.104629 50.05999
## 55   6.110890 50.06007
## 56   6.111556 50.05172
## 57   6.111769 50.04904
## 58   6.118320 50.04544
## 59   6.118609 50.04177
## 60   6.125159 50.03817
## 61   6.118908 50.03809
## 62   6.119489 50.03073
## 63   6.126340 50.02346
## 64   6.132589 50.02354
## 65   6.132890 50.01986
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## 70   6.140031 50.00891
## 71   6.140320 50.00523
## 72   6.134349 50.00147
## 73   6.134647 49.99779
## 74   6.128380 49.99772
## 75   6.128678 49.99404
## 76   6.141200 49.99420
## 77   6.141489 49.99052
## 78   6.148049 49.98692
## 79   6.160850 49.98341
## 80   6.154601 49.98332
## 81   6.155072 49.97744
## 82   6.154140 49.97733
## 83   6.152314 49.97695
## 84   6.149750 49.97596
## 85   6.144959 49.97356
## 86   6.143180 49.97294
## 87   6.141286 49.97258
## 88   6.139316 49.97241
## 89   6.134291 49.97238
## 90   6.131309 49.97256
## 91   6.129381 49.97283
## 92   6.127553 49.97331
## 93   6.126048 49.97403
## 94   6.125395 49.97445
## 95   6.124285 49.97540
## 96   6.123444 49.97648
## 97   6.121974 49.97880
## 98   6.120296 49.98049
## 99   6.118977 49.98154
## 100 6.117520 49.98251
## 101 6.115886 49.98333
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## 103 6.114041 49.98390
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## 111 6.093073 49.98602
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## 114 6.088713 49.98140
## 115 6.086698 49.98026
## 116 6.085132 49.97970
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## 118 6.081188 49.97834
## 119 6.079884 49.97753
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## 133 6.050148 49.95265
## 134 6.050135 49.95220
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## 136 6.050636 49.95012
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## 139 6.049150 49.94836
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## 169 6.050364 49.98949
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## 218 5.970414 50.03364
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## 220 5.968068 50.03463
## 221 5.963571 50.03564
## 222 5.961040 50.03632
## 223 5.957327 50.03486
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## 234 5.932308 50.02546
## 235 5.931502 50.02573
## 236 5.930055 50.02644
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## 238 5.923949 50.02999
## 239 5.923222 50.03017
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## 241 5.920168 50.03021
## 242 5.919308 50.02999
## 243 5.917842 50.02931
## 244 5.916735 50.02837
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## 260 5.916216 50.01114
## 261 5.915893 50.01058
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## 276 5.881522 49.99375
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```

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## 282 5.869738 49.99729
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## 289 5.856763 49.99145
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## 292 5.842359 49.99117
## 293 5.840155 49.99109
## 294 5.839046 49.99097
## 295 5.835201 49.99450
## 296 5.827700 49.99947
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## 305 5.859366 50.06018
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## 308 5.874896 50.07390
## 309 5.877115 50.07451
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## 311 5.889813 50.07829
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## 313 5.891685 50.08677
## 314 5.894246 50.09442
## 315 5.899429 50.10030
## 316 5.899872 50.10210
## 317 5.901382 50.10821
## 318 5.902342 50.10977
## 319 5.905460 50.11127
## 320 5.925416 50.12087
## 321 5.936615 50.12626
## 322 5.951639 50.13350
## 323 5.954149 50.13470
## 324 5.967641 50.17080
## 325 5.969772 50.17130
## 326 5.987989 50.17551
## 327 5.989902 50.17545
## 328 6.002239 50.17652
## 329 6.020686 50.18063
## 330 6.024930 50.18162
## 331 6.026519 50.17767
##
##
##
## Slot "plotOrder":
```

```
## [1] 1
##
## Slot "labpt":
## [1]   6.009082 50.070636
##
## Slot "ID":
## [1] "1"
##
## Slot "area":
## [1] 0.03921637
##
##
## [[2]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   6.127425 49.866140
##
## Slot "area":
## [1] 0.02734593
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##             x        y
## 332 6.178368 49.87682
## 333 6.185479 49.87053
## 334 6.189417 49.87241
## 335 6.190995 49.87328
## 336 6.193213 49.87470
## 337 6.194545 49.87572
## 338 6.195677 49.87683
## 339 6.196470 49.87802
## 340 6.197579 49.88107
## 341 6.198232 49.88224
## 342 6.198678 49.88276
## 343 6.199794 49.88369
## 344 6.201142 49.88446
## 345 6.201888 49.88477
## 346 6.206039 49.88601
## 347 6.210001 49.88737
## 348 6.213528 49.88824
## 349 6.217536 49.88952
## 350 6.219369 49.88990
## 351 6.220374 49.89003
## 352 6.224523 49.89017
## 353 6.229828 49.89002
## 354 6.235145 49.88966
```

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## 355 6.239243 49.88915
## 356 6.238956 49.89240
## 357 6.243079 49.89246
## 358 6.243401 49.88878
## 359 6.249869 49.88519
## 360 6.250188 49.88151
## 361 6.256310 49.88161
## 362 6.256640 49.87793
## 363 6.262689 49.87804
## 364 6.268979 49.87448
## 365 6.274680 49.87463
## 366 6.279789 49.87488
## 367 6.280300 49.87117
## 368 6.285348 49.87145
## 369 6.286290 49.86403
## 370 6.291591 49.86431
## 371 6.296899 49.86830
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## 375 6.303638 49.86117
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## 377 6.309999 49.85776
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## 379 6.315773 49.85115
## 380 6.315490 49.85073
## 381 6.314039 49.84713
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## 384 6.311388 49.84475
## 385 6.309841 49.84412
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## 387 6.306700 49.84364
## 388 6.303394 49.84359
## 389 6.290839 49.84404
## 390 6.286313 49.84428
## 391 6.284100 49.84450
## 392 6.281958 49.84485
## 393 6.276210 49.84625
## 394 6.275156 49.84532
## 395 6.274245 49.84437
## 396 6.272662 49.84208
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## 403 6.263642 49.83028
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## 406 6.262432 49.82833
## 407 6.262528 49.82780
## 408 6.263139 49.82684
```

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## 425 6.247712 49.79268
## 426 6.247147 49.79145
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## 440 6.232485 49.79603
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## 458 6.194964 49.80562
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## 462 6.190509 49.81410
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## 463 6.190517 49.81704
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## 475 6.172102 49.82137
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## 491 6.130614 49.82121
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## 631 6.016469 49.90100
## 632 6.017107 49.90215
## 633 6.017511 49.90342
## 634 6.018246 49.90733
## 635 6.018692 49.90861
## 636 6.019036 49.90922
## 637 6.019943 49.91029
## 638 6.021096 49.91126
## 639 6.022413 49.91215
## 640 6.023829 49.91296
## 641 6.026094 49.91398
## 642 6.029433 49.91493
## 643 6.031018 49.91549
## 644 6.032399 49.91624
## 645 6.033012 49.91667
## 646 6.034031 49.91767
## 647 6.034424 49.91825
## 648 6.034973 49.91949
## 649 6.035978 49.92239
## 650 6.038676 49.92565
## 651 6.040221 49.92797
## 652 6.042452 49.93054
## 653 6.042819 49.93110
## 654 6.043322 49.93235
## 655 6.043506 49.93432
## 656 6.043283 49.93563
## 657 6.042765 49.93682
## 658 6.040750 49.93983
## 659 6.040466 49.94194
## 660 6.040637 49.94320
## 661 6.040846 49.94380
## 662 6.041517 49.94484
## 663 6.042965 49.94611
## 664 6.046246 49.94707
## 665 6.047822 49.94764
## 666 6.049150 49.94836
## 667 6.049694 49.94876
## 668 6.050463 49.94965
## 669 6.050636 49.95012
## 670 6.050645 49.95057
## 671 6.050135 49.95220
## 672 6.050148 49.95265
## 673 6.050330 49.95312
## 674 6.051125 49.95399
## 675 6.052355 49.95471
## 676 6.053975 49.95520
## 677 6.055827 49.95543
## 678 6.063068 49.95563
```

```
## 679 6.065887 49.96043
## 680 6.068609 49.96354
## 681 6.070158 49.96585
## 682 6.072911 49.96894
## 683 6.074422 49.97127
## 684 6.077146 49.97436
## 685 6.078795 49.97659
## 686 6.079884 49.97753
## 687 6.081188 49.97834
## 688 6.082650 49.97898
## 689 6.085132 49.97970
## 690 6.086698 49.98026
## 691 6.088713 49.98140
## 692 6.089803 49.98233
## 693 6.091992 49.98504
## 694 6.093073 49.98602
## 695 6.094872 49.98745
## 696 6.099638 49.98413
## 697 6.102471 49.98241
## 698 6.102660 49.97812
## 699 6.102476 49.96965
## 700 6.102259 49.96506
## 701 6.101840 49.96207
## 702 6.101066 49.95995
## 703 6.099239 49.95738
## 704 6.098499 49.95602
## 705 6.097907 49.95381
## 706 6.097306 49.94923
## 707 6.096970 49.94774
## 708 6.096396 49.94631
## 709 6.094599 49.94373
## 710 6.093868 49.94236
## 711 6.093430 49.94090
## 712 6.092986 49.93785
## 713 6.095138 49.93583
## 714 6.095967 49.93473
## 715 6.096514 49.93349
## 716 6.097162 49.93093
## 717 6.097620 49.92968
## 718 6.101310 49.92408
## 719 6.102352 49.92309
## 720 6.103647 49.92225
## 721 6.104376 49.92189
## 722 6.106026 49.92134
## 723 6.108727 49.92088
## 724 6.110112 49.91949
## 725 6.110729 49.91854
## 726 6.110854 49.91806
## 727 6.110823 49.91759
## 728 6.110152 49.91586
## 729 6.110111 49.91537
## 730 6.110233 49.91486
## 731 6.110501 49.91435
## 732 6.110879 49.91386
```

```
## 733 6.111872 49.91290
## 734 6.113747 49.91157
## 735 6.115191 49.91079
## 736 6.115973 49.91045
## 737 6.116798 49.91017
## 738 6.118436 49.90981
## 739 6.122633 49.90924
## 740 6.124274 49.90887
## 741 6.125895 49.90824
## 742 6.127363 49.90746
## 743 6.128717 49.90658
## 744 6.129982 49.90563
## 745 6.131654 49.90408
## 746 6.132918 49.90234
## 747 6.134239 49.89993
## 748 6.136256 49.89899
## 749 6.138233 49.89845
## 750 6.140748 49.89812
## 751 6.145555 49.89771
## 752 6.147415 49.89739
## 753 6.148301 49.89713
## 754 6.149799 49.89645
## 755 6.151043 49.89558
## 756 6.152017 49.89460
## 757 6.153089 49.89294
## 758 6.153927 49.89189
## 759 6.155035 49.89096
## 760 6.155682 49.89055
## 761 6.157150 49.88987
## 762 6.158010 49.88961
## 763 6.159805 49.88925
## 764 6.162564 49.88882
## 765 6.164378 49.88840
## 766 6.166071 49.88775
## 767 6.167637 49.88692
## 768 6.169120 49.88601
## 769 6.171238 49.88453
## 770 6.174469 49.88191
## 771 6.176010 49.88023
## 772 6.177477 49.87787
## 773 6.178368 49.87682
##
##
##
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   6.127425 49.866140
##
## Slot "ID":
## [1] "2"
##
## Slot "area":
```

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## [1] 0.02734593
##
##
## [[3]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]  5.886502 49.800138
##
## Slot "area":
## [1] 0.03240219
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##              x        y
## 774  5.881378 49.87015
## 775  5.881672 49.86887
## 776  5.886637 49.86884
## 777  5.888580 49.86902
## 778  5.889531 49.86919
## 779  5.891358 49.86978
## 780  5.893010 49.87056
## 781  5.894516 49.87146
## 782  5.895867 49.87247
## 783  5.896998 49.87360
## 784  5.897441 49.87421
## 785  5.898018 49.87557
## 786  5.898284 49.87697
## 787  5.898660 49.88197
## 788  5.899240 49.88403
## 789  5.899600 49.88468
## 790  5.900492 49.88575
## 791  5.902771 49.88764
## 792  5.904899 49.88562
## 793  5.905711 49.88452
## 794  5.906010 49.88390
## 795  5.906375 49.88261
## 796  5.906878 49.87868
## 797  5.907245 49.87740
## 798  5.907545 49.87678
## 799  5.907955 49.87617
## 800  5.908996 49.87502
## 801  5.912557 49.87175
## 802  5.913463 49.87054
## 803  5.913975 49.86927
## 804  5.914212 49.86796
## 805  5.914371 49.86328
```

```
## 806   5.914677 49.86133
## 807   5.914894 49.86071
## 808   5.915545 49.85961
## 809   5.916890 49.85825
## 810   5.920084 49.85863
## 811   5.924633 49.85954
## 812   5.926035 49.85992
## 813   5.927547 49.86057
## 814   5.928851 49.86140
## 815   5.929905 49.86237
## 816   5.931422 49.86465
## 817   5.933575 49.86726
## 818   5.935050 49.86963
## 819   5.935853 49.87058
## 820   5.937012 49.87147
## 821   5.938443 49.87217
## 822   5.939275 49.87241
## 823   5.940027 49.87253
## 824   5.941555 49.87256
## 825   5.943053 49.87231
## 826   5.943873 49.87205
## 827   5.945336 49.87133
## 828   5.946667 49.87048
## 829   5.951830 49.86671
## 830   5.953227 49.86586
## 831   5.954742 49.86513
## 832   5.956410 49.86462
## 833   5.958159 49.86433
## 834   5.963542 49.86394
## 835   5.965315 49.86373
## 836   5.967033 49.86336
## 837   5.968710 49.86271
## 838   5.970238 49.86190
## 839   5.972382 49.86051
## 840   5.977841 49.85651
## 841   5.981062 49.85390
## 842   5.983510 49.85149
## 843   5.976303 49.84980
## 844   5.974668 49.84925
## 845   5.973270 49.84850
## 846   5.972660 49.84805
## 847   5.971676 49.84702
## 848   5.971327 49.84641
## 849   5.971098 49.84578
## 850   5.970919 49.84450
## 851   5.971225 49.84257
## 852   5.971809 49.84139
## 853   5.973700 49.83869
## 854   5.974382 49.83667
## 855   5.974676 49.83311
## 856   5.974464 49.82880
## 857   5.974018 49.82671
## 858   5.973404 49.82539
## 859   5.973006 49.82483
```

```
## 860    5.971527 49.82329
## 861    5.967658 49.81974
## 862    5.972607 49.81783
## 863    5.974183 49.81734
## 864    5.975123 49.81714
## 865    5.977054 49.81691
## 866    5.979975 49.81691
## 867    5.981868 49.81717
## 868    5.982714 49.81738
## 869    5.986647 49.81872
## 870    5.990126 49.81965
## 871    5.994852 49.82134
## 872    5.998350 49.82226
## 873    6.003078 49.82394
## 874    6.006567 49.82486
## 875    6.010529 49.82620
## 876    6.012314 49.82660
## 877    6.014251 49.82679
## 878    6.016231 49.82684
## 879    6.020203 49.82664
## 880    6.023081 49.82617
## 881    6.027617 49.82478
## 882    6.025105 49.82245
## 883    6.023852 49.82092
## 884    6.023334 49.81964
## 885    6.023213 49.81899
## 886    6.023210 49.81767
## 887    6.023543 49.81637
## 888    6.024268 49.81520
## 889    6.025270 49.81419
## 890    6.028001 49.81197
## 891    6.028819 49.81106
## 892    6.029069 49.81056
## 893    6.029145 49.81001
## 894    6.028999 49.80947
## 895    6.028676 49.80898
## 896    6.028222 49.80855
## 897    6.027038 49.80783
## 898    6.025550 49.80731
## 899    6.022229 49.80643
## 900    6.020590 49.80576
## 901    6.018209 49.80455
## 902    6.015914 49.80323
## 903    6.013746 49.80183
## 904    6.012427 49.80083
## 905    6.011298 49.79976
## 906    6.010848 49.79916
## 907    6.010260 49.79789
## 908    6.009904 49.79591
## 909    6.009947 49.79318
## 910    6.010555 49.78965
## 911    6.007829 49.78928
## 912    6.002719 49.78827
## 913    6.001015 49.78782
```

```
## 914   5.997002 49.78655
## 915   5.995162 49.78624
## 916   5.993274 49.78603
## 917   5.990877 49.78419
## 918   5.989923 49.78313
## 919   5.989553 49.78252
## 920   5.988938 49.78057
## 921   5.988815 49.77924
## 922   5.988875 49.77790
## 923   5.989394 49.77593
## 924   5.990184 49.77471
## 925   5.991291 49.77362
## 926   5.993664 49.77164
## 927   5.994594 49.77062
## 928   5.994892 49.77007
## 929   5.995002 49.76946
## 930   5.994872 49.76885
## 931   5.994549 49.76829
## 932   5.993527 49.76729
## 933   5.991454 49.76598
## 934   5.989022 49.76490
## 935   5.985591 49.76398
## 936   5.983986 49.76344
## 937   5.982587 49.76271
## 938   5.981417 49.76180
## 939   5.980578 49.76066
## 940   5.980315 49.76004
## 941   5.980026 49.75874
## 942   5.979951 49.75740
## 943   5.980026 49.75604
## 944   5.980496 49.75350
## 945   5.982200 49.75188
## 946   5.986144 49.74841
## 947   5.987048 49.74736
## 948   5.988218 49.74548
## 949   5.988975 49.74448
## 950   5.990000 49.74345
## 951   5.993468 49.74047
## 952   5.994499 49.73944
## 953   5.995257 49.73843
## 954   5.996361 49.73653
## 955   5.997999 49.73437
## 956   5.998711 49.73325
## 957   5.999100 49.73225
## 958   5.999455 49.73071
## 959   5.997127 49.72882
## 960   5.996205 49.72778
## 961   5.995843 49.72717
## 962   5.995336 49.72593
## 963   5.994591 49.72338
## 964   5.992929 49.71941
## 965   5.988688 49.71985
## 966   5.985817 49.72002
## 967   5.982812 49.72005
```

```
## 968   5.980852 49.71995
## 969   5.978964 49.71967
## 970   5.978123 49.71947
## 971   5.974117 49.71826
## 972   5.972301 49.71796
## 973   5.967622 49.71741
## 974   5.965844 49.71694
## 975   5.964221 49.71626
## 976   5.962697 49.71545
## 977   5.954741 49.71043
## 978   5.951755 49.70873
## 979   5.949354 49.70771
## 980   5.946764 49.70700
## 981   5.945072 49.70645
## 982   5.942692 49.70532
## 983   5.938943 49.70310
## 984   5.933084 49.69933
## 985   5.929104 49.70219
## 986   5.923679 49.70326
## 987   5.920444 49.70440
## 988   5.916480 49.70671
## 989   5.911072 49.71106
## 990   5.908281 49.71231
## 991   5.904775 49.71291
## 992   5.902961 49.71292
## 993   5.899532 49.71239
## 994   5.891976 49.70977
## 995   5.887047 49.70846
## 996   5.889624 49.71011
## 997   5.882627 49.71611
## 998   5.876872 49.72215
## 999   5.869064 49.72721
## 1000  5.860460 49.72802
## 1001  5.851987 49.72604
## 1002  5.848493 49.72523
## 1003  5.831935 49.72578
## 1004  5.831954 49.72635
## 1005  5.832017 49.72825
## 1006  5.827349 49.74523
## 1007  5.826678 49.74612
## 1008  5.794256 49.78923
## 1009  5.792281 49.79042
## 1010  5.782797 49.79613
## 1011  5.782459 49.79633
## 1012  5.768496 49.79638
## 1013  5.758751 49.79641
## 1014  5.757694 49.79642
## 1015  5.757602 49.79770
## 1016  5.757108 49.80459
## 1017  5.754362 49.81312
## 1018  5.753273 49.81400
## 1019  5.749579 49.81700
## 1020  5.747794 49.81845
## 1021  5.748942 49.82019
```

```
## 1022 5.751540 49.82414
## 1023 5.749722 49.83175
## 1024 5.748223 49.83467
## 1025 5.746118 49.83877
## 1026 5.750223 49.84066
## 1027 5.750579 49.84580
## 1028 5.753318 49.84573
## 1029 5.753322 49.84851
## 1030 5.753330 49.85362
## 1031 5.750109 49.85498
## 1032 5.753332 49.85527
## 1033 5.755500 49.85546
## 1034 5.757740 49.85566
## 1035 5.759565 49.85875
## 1036 5.758203 49.86237
## 1037 5.758098 49.86265
## 1038 5.757266 49.86830
## 1039 5.758082 49.86950
## 1040 5.768019 49.86924
## 1041 5.773461 49.86909
## 1042 5.775018 49.86905
## 1043 5.776657 49.86988
## 1044 5.782471 49.87613
## 1045 5.782749 49.87642
## 1046 5.782332 49.87658
## 1047 5.781986 49.87769
## 1048 5.785317 49.87725
## 1049 5.786361 49.87724
## 1050 5.788490 49.87603
## 1051 5.788075 49.87722
## 1052 5.791665 49.87719
## 1053 5.797742 49.87772
## 1054 5.799605 49.87737
## 1055 5.801372 49.87654
## 1056 5.802742 49.87540
## 1057 5.804718 49.87239
## 1058 5.805997 49.87098
## 1059 5.807741 49.86988
## 1060 5.809893 49.86916
## 1061 5.813406 49.86893
## 1062 5.826849 49.87008
## 1063 5.831700 49.87105
## 1064 5.833945 49.87203
## 1065 5.835810 49.87329
## 1066 5.839860 49.87755
## 1067 5.846624 49.88577
## 1068 5.852952 49.89071
## 1069 5.856606 49.89461
## 1070 5.863834 49.89006
## 1071 5.866493 49.88812
## 1072 5.868258 49.88659
## 1073 5.869220 49.88551
## 1074 5.870331 49.88374
## 1075 5.871163 49.88263
```

```
## 1076 5.872744 49.88110
## 1077 5.875642 49.87862
## 1078 5.877116 49.87704
## 1079 5.878558 49.87468
## 1080 5.880197 49.87252
## 1081 5.880909 49.87140
## 1082 5.881378 49.87015
##
##
##
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   5.886502 49.800138
##
## Slot "ID":
## [1] "3"
##
## Slot "area":
## [1] 0.03240219
##
##
## [[4]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   6.165081 49.928861
##
## Slot "area":
## [1] 0.009541371
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##             x        y
## 1083 6.131309 49.97256
## 1084 6.134291 49.97238
## 1085 6.139316 49.97241
## 1086 6.141286 49.97258
## 1087 6.143180 49.97294
## 1088 6.144959 49.97356
## 1089 6.149750 49.97596
## 1090 6.152314 49.97695
## 1091 6.154140 49.97733
## 1092 6.155072 49.97744
## 1093 6.155387 49.97350
## 1094 6.156370 49.96126
```

```
## 1095 6.162619 49.96134
## 1096 6.163209 49.95398
## 1097 6.175720 49.95414
## 1098 6.175129 49.96150
## 1099 6.168880 49.96142
## 1100 6.168579 49.96509
## 1101 6.170826 49.96512
## 1102 6.172098 49.96364
## 1103 6.178999 49.96033
## 1104 6.181153 49.96424
## 1105 6.183731 49.96893
## 1106 6.190536 49.97124
## 1107 6.195177 49.96710
## 1108 6.195669 49.96068
## 1109 6.198379 49.95604
## 1110 6.203238 49.95464
## 1111 6.208914 49.95456
## 1112 6.212993 49.95450
## 1113 6.219171 49.95164
## 1114 6.222652 49.94553
## 1115 6.225733 49.94054
## 1116 6.225665 49.93446
## 1117 6.224320 49.92950
## 1118 6.224450 49.92308
## 1119 6.225484 49.92281
## 1120 6.231800 49.92116
## 1121 6.234300 49.91732
## 1122 6.232714 49.91327
## 1123 6.230765 49.90956
## 1124 6.233480 49.90480
## 1125 6.238765 49.89900
## 1126 6.237215 49.89745
## 1127 6.234840 49.89602
## 1128 6.236600 49.89605
## 1129 6.236907 49.89237
## 1130 6.238956 49.89240
## 1131 6.239243 49.88915
## 1132 6.235145 49.88966
## 1133 6.229828 49.89002
## 1134 6.224523 49.89017
## 1135 6.220374 49.89003
## 1136 6.219369 49.88990
## 1137 6.217536 49.88952
## 1138 6.213528 49.88824
## 1139 6.210001 49.88737
## 1140 6.206039 49.88601
## 1141 6.201888 49.88477
## 1142 6.201142 49.88446
## 1143 6.199794 49.88369
## 1144 6.198678 49.88276
## 1145 6.198232 49.88224
## 1146 6.197579 49.88107
## 1147 6.196470 49.87802
## 1148 6.195677 49.87683
```

```
## 1149 6.194545 49.87572
## 1150 6.193213 49.87470
## 1151 6.190995 49.87328
## 1152 6.189417 49.87241
## 1153 6.185479 49.87053
## 1154 6.178368 49.87682
## 1155 6.177477 49.87787
## 1156 6.176010 49.88023
## 1157 6.174469 49.88191
## 1158 6.171238 49.88453
## 1159 6.169120 49.88601
## 1160 6.167637 49.88692
## 1161 6.166071 49.88775
## 1162 6.164378 49.88840
## 1163 6.162564 49.88882
## 1164 6.159805 49.88925
## 1165 6.158010 49.88961
## 1166 6.157150 49.88987
## 1167 6.155682 49.89055
## 1168 6.155035 49.89096
## 1169 6.153927 49.89189
## 1170 6.153089 49.89294
## 1171 6.152017 49.89460
## 1172 6.151043 49.89558
## 1173 6.149799 49.89645
## 1174 6.148301 49.89713
## 1175 6.147415 49.89739
## 1176 6.145555 49.89771
## 1177 6.140748 49.89812
## 1178 6.138233 49.89845
## 1179 6.136256 49.89899
## 1180 6.134239 49.89993
## 1181 6.132918 49.90234
## 1182 6.131654 49.90408
## 1183 6.129982 49.90563
## 1184 6.128717 49.90658
## 1185 6.127363 49.90746
## 1186 6.125895 49.90824
## 1187 6.124274 49.90887
## 1188 6.122633 49.90924
## 1189 6.118436 49.90981
## 1190 6.116798 49.91017
## 1191 6.115973 49.91045
## 1192 6.115191 49.91079
## 1193 6.113747 49.91157
## 1194 6.111872 49.91290
## 1195 6.110879 49.91386
## 1196 6.110501 49.91435
## 1197 6.110233 49.91486
## 1198 6.110111 49.91537
## 1199 6.110152 49.91586
## 1200 6.110823 49.91759
## 1201 6.110854 49.91806
## 1202 6.110729 49.91854
```

```
## 1203 6.110112 49.91949
## 1204 6.108727 49.92088
## 1205 6.106026 49.92134
## 1206 6.104376 49.92189
## 1207 6.103647 49.92225
## 1208 6.102352 49.92309
## 1209 6.101310 49.92408
## 1210 6.097620 49.92968
## 1211 6.097162 49.93093
## 1212 6.096514 49.93349
## 1213 6.095967 49.93473
## 1214 6.095138 49.93583
## 1215 6.092986 49.93785
## 1216 6.093430 49.94090
## 1217 6.093868 49.94236
## 1218 6.094599 49.94373
## 1219 6.096396 49.94631
## 1220 6.096970 49.94774
## 1221 6.097306 49.94923
## 1222 6.097907 49.95381
## 1223 6.098499 49.95602
## 1224 6.099239 49.95738
## 1225 6.101066 49.95995
## 1226 6.101840 49.96207
## 1227 6.102259 49.96506
## 1228 6.102476 49.96965
## 1229 6.102660 49.97812
## 1230 6.102471 49.98241
## 1231 6.106437 49.98369
## 1232 6.108197 49.98405
## 1233 6.109166 49.98415
## 1234 6.112107 49.98416
## 1235 6.114041 49.98390
## 1236 6.114977 49.98366
## 1237 6.115886 49.98333
## 1238 6.117520 49.98251
## 1239 6.118977 49.98154
## 1240 6.120296 49.98049
## 1241 6.121974 49.97880
## 1242 6.123444 49.97648
## 1243 6.124285 49.97540
## 1244 6.125395 49.97445
## 1245 6.126048 49.97403
## 1246 6.127553 49.97331
## 1247 6.129381 49.97283
## 1248 6.131309 49.97256
##
##
##
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   6.165081 49.928861
```

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##
## Slot "ID":
## [1] "4"
##
## Slot "area":
## [1] 0.009541371
##
##
## [[5]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   5.914545 49.938918
##
## Slot "area":
## [1] 0.03295997
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##              x        y
## 1249 5.977929 50.02602
## 1250 5.982312 50.02295
## 1251 5.981743 50.02077
## 1252 5.981830 50.01882
## 1253 5.982258 50.01762
## 1254 5.984316 50.01416
## 1255 5.989406 50.01279
## 1256 5.991280 50.01244
## 1257 5.995080 50.01188
## 1258 5.996910 50.01148
## 1259 6.000885 50.01009
## 1260 6.002627 50.00965
## 1261 6.004528 50.00937
## 1262 6.010383 50.00887
## 1263 6.012285 50.00854
## 1264 6.013202 50.00830
## 1265 6.014892 50.00761
## 1266 6.016419 50.00676
## 1267 6.021967 50.00285
## 1268 6.023400 50.00195
## 1269 6.024971 50.00121
## 1270 6.025845 50.00093
## 1271 6.026772 50.00075
## 1272 6.028662 50.00068
## 1273 6.030437 50.00094
## 1274 6.034289 50.00223
## 1275 6.037730 50.00321
```

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## 1276 6.040488 50.00438
## 1277 6.045314 50.00506
## 1278 6.047326 50.00516
## 1279 6.050323 50.00507
## 1280 6.052269 50.00484
## 1281 6.054124 50.00443
## 1282 6.055623 50.00386
## 1283 6.057764 50.00282
## 1284 6.058357 49.99946
## 1285 6.058390 49.99742
## 1286 6.058220 49.99609
## 1287 6.057808 49.99479
## 1288 6.057466 49.99416
## 1289 6.057000 49.99355
## 1290 6.055826 49.99244
## 1291 6.054438 49.99146
## 1292 6.052905 49.99057
## 1293 6.050364 49.98949
## 1294 6.048524 49.98904
## 1295 6.043837 49.98854
## 1296 6.041985 49.98822
## 1297 6.040126 49.98762
## 1298 6.038389 49.98684
## 1299 6.034355 49.98453
## 1300 6.031463 49.98246
## 1301 6.030270 49.98131
## 1302 6.029792 49.98068
## 1303 6.029433 49.98003
## 1304 6.028980 49.97868
## 1305 6.028605 49.97588
## 1306 6.028342 49.96943
## 1307 6.028433 49.96732
## 1308 6.028948 49.96530
## 1309 6.029737 49.96412
## 1310 6.030829 49.96315
## 1311 6.032851 49.96202
## 1312 6.035220 49.96119
## 1313 6.036710 49.96056
## 1314 6.038578 49.95930
## 1315 6.039503 49.95826
## 1316 6.039838 49.95765
## 1317 6.040232 49.95639
## 1318 6.040833 49.95113
## 1319 6.041250 49.94992
## 1320 6.042965 49.94611
## 1321 6.041517 49.94484
## 1322 6.040846 49.94380
## 1323 6.040637 49.94320
## 1324 6.040466 49.94194
## 1325 6.040750 49.93983
## 1326 6.042765 49.93682
## 1327 6.043283 49.93563
## 1328 6.043506 49.93432
## 1329 6.043322 49.93235
```

```
## 1330 6.042819 49.93110
## 1331 6.042452 49.93054
## 1332 6.040221 49.92797
## 1333 6.038676 49.92565
## 1334 6.035978 49.92239
## 1335 6.034973 49.91949
## 1336 6.034424 49.91825
## 1337 6.034031 49.91767
## 1338 6.033012 49.91667
## 1339 6.032399 49.91624
## 1340 6.031018 49.91549
## 1341 6.029433 49.91493
## 1342 6.026094 49.91398
## 1343 6.023829 49.91296
## 1344 6.022413 49.91215
## 1345 6.021096 49.91126
## 1346 6.019943 49.91029
## 1347 6.019036 49.90922
## 1348 6.018692 49.90861
## 1349 6.018246 49.90733
## 1350 6.017511 49.90342
## 1351 6.017107 49.90215
## 1352 6.016469 49.90100
## 1353 6.014537 49.89835
## 1354 6.014063 49.89709
## 1355 6.013864 49.89515
## 1356 6.014033 49.89385
## 1357 6.014444 49.89268
## 1358 6.015349 49.89080
## 1359 6.014710 49.88899
## 1360 6.013251 49.88621
## 1361 6.012515 49.88502
## 1362 6.012029 49.88445
## 1363 6.010867 49.88339
## 1364 6.009546 49.88239
## 1365 6.007406 49.88097
## 1366 6.004375 49.87918
## 1367 6.001940 49.87804
## 1368 6.000184 49.87750
## 1369 5.999262 49.87733
## 1370 5.994669 49.87693
## 1371 5.992942 49.87661
## 1372 5.992196 49.87635
## 1373 5.990947 49.87565
## 1374 5.990471 49.87523
## 1375 5.990123 49.87475
## 1376 5.989941 49.87423
## 1377 5.989958 49.87371
## 1378 5.990125 49.87322
## 1379 5.991262 49.87130
## 1380 5.991632 49.87011
## 1381 5.991672 49.86820
## 1382 5.991358 49.86694
## 1383 5.991078 49.86634
```

```
## 1384 5.989517 49.86431
## 1385 5.988853 49.86325
## 1386 5.988588 49.86203
## 1387 5.988652 49.86140
## 1388 5.988855 49.86078
## 1389 5.989178 49.86023
## 1390 5.990085 49.85920
## 1391 5.991758 49.85778
## 1392 5.988710 49.85582
## 1393 5.986400 49.85418
## 1394 5.985363 49.85331
## 1395 5.983510 49.85149
## 1396 5.981062 49.85390
## 1397 5.977841 49.85651
## 1398 5.972382 49.86051
## 1399 5.970238 49.86190
## 1400 5.968710 49.86271
## 1401 5.967033 49.86336
## 1402 5.965315 49.86373
## 1403 5.963542 49.86394
## 1404 5.958159 49.86433
## 1405 5.956410 49.86462
## 1406 5.954742 49.86513
## 1407 5.953227 49.86586
## 1408 5.951830 49.86671
## 1409 5.946667 49.87048
## 1410 5.945336 49.87133
## 1411 5.943873 49.87205
## 1412 5.943053 49.87231
## 1413 5.941555 49.87256
## 1414 5.940027 49.87253
## 1415 5.939275 49.87241
## 1416 5.938443 49.87217
## 1417 5.937012 49.87147
## 1418 5.935853 49.87058
## 1419 5.935050 49.86963
## 1420 5.933575 49.86726
## 1421 5.931422 49.86465
## 1422 5.929905 49.86237
## 1423 5.928851 49.86140
## 1424 5.927547 49.86057
## 1425 5.926035 49.85992
## 1426 5.924633 49.85954
## 1427 5.920084 49.85863
## 1428 5.916890 49.85825
## 1429 5.915545 49.85961
## 1430 5.914894 49.86071
## 1431 5.914677 49.86133
## 1432 5.914371 49.86328
## 1433 5.914212 49.86796
## 1434 5.913975 49.86927
## 1435 5.913463 49.87054
## 1436 5.912557 49.87175
## 1437 5.908996 49.87502
```

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## 1438 5.907955 49.87617
## 1439 5.907545 49.87678
## 1440 5.907245 49.87740
## 1441 5.906878 49.87868
## 1442 5.906375 49.88261
## 1443 5.906010 49.88390
## 1444 5.905711 49.88452
## 1445 5.904899 49.88562
## 1446 5.902771 49.88764
## 1447 5.900492 49.88575
## 1448 5.899600 49.88468
## 1449 5.899240 49.88403
## 1450 5.898660 49.88197
## 1451 5.898284 49.87697
## 1452 5.898018 49.87557
## 1453 5.897441 49.87421
## 1454 5.896998 49.87360
## 1455 5.895867 49.87247
## 1456 5.894516 49.87146
## 1457 5.893010 49.87056
## 1458 5.891358 49.86978
## 1459 5.889531 49.86919
## 1460 5.888580 49.86902
## 1461 5.886637 49.86884
## 1462 5.881672 49.86887
## 1463 5.881378 49.87015
## 1464 5.880909 49.87140
## 1465 5.880197 49.87252
## 1466 5.878558 49.87468
## 1467 5.877116 49.87704
## 1468 5.875642 49.87862
## 1469 5.872744 49.88110
## 1470 5.871163 49.88263
## 1471 5.870331 49.88374
## 1472 5.869220 49.88551
## 1473 5.868258 49.88659
## 1474 5.866493 49.88812
## 1475 5.863834 49.89006
## 1476 5.856606 49.89461
## 1477 5.852952 49.89071
## 1478 5.846624 49.88577
## 1479 5.839860 49.87755
## 1480 5.835810 49.87329
## 1481 5.833945 49.87203
## 1482 5.831700 49.87105
## 1483 5.826849 49.87008
## 1484 5.813406 49.86893
## 1485 5.809893 49.86916
## 1486 5.807741 49.86988
## 1487 5.805997 49.87098
## 1488 5.804718 49.87239
## 1489 5.802742 49.87540
## 1490 5.801372 49.87654
## 1491 5.799605 49.87737
```

```
## 1492 5.797742 49.87772
## 1493 5.791665 49.87719
## 1494 5.788075 49.87722
## 1495 5.787906 49.87771
## 1496 5.786120 49.88286
## 1497 5.773842 49.88851
## 1498 5.758537 49.89337
## 1499 5.756096 49.89428
## 1500 5.745097 49.89841
## 1501 5.744578 49.90067
## 1502 5.744249 49.90210
## 1503 5.744140 49.90258
## 1504 5.746311 49.90457
## 1505 5.753683 49.91133
## 1506 5.759871 49.91224
## 1507 5.766617 49.91985
## 1508 5.767329 49.92139
## 1509 5.768825 49.92462
## 1510 5.772483 49.93232
## 1511 5.778143 49.93843
## 1512 5.779319 49.94443
## 1513 5.778380 49.95050
## 1514 5.778992 49.95263
## 1515 5.781014 49.95968
## 1516 5.791535 49.96042
## 1517 5.795302 49.96423
## 1518 5.798164 49.96386
## 1519 5.801381 49.96344
## 1520 5.801556 49.96339
## 1521 5.810860 49.96092
## 1522 5.815623 49.96481
## 1523 5.816182 49.96894
## 1524 5.816674 49.97258
## 1525 5.827108 49.97401
## 1526 5.827370 49.97405
## 1527 5.836931 49.97554
## 1528 5.843355 49.97995
## 1529 5.843308 49.98331
## 1530 5.843251 49.98710
## 1531 5.839046 49.99097
## 1532 5.840155 49.99109
## 1533 5.842359 49.99117
## 1534 5.852455 49.99102
## 1535 5.854650 49.99113
## 1536 5.856763 49.99145
## 1537 5.858733 49.99203
## 1538 5.863538 49.99393
## 1539 5.864643 49.99466
## 1540 5.866568 49.99631
## 1541 5.867994 49.99700
## 1542 5.868828 49.99722
## 1543 5.869738 49.99729
## 1544 5.870646 49.99720
## 1545 5.871486 49.99697
```

```
## 1546 5.876955 49.99426
## 1547 5.878773 49.99379
## 1548 5.880604 49.99368
## 1549 5.881522 49.99375
## 1550 5.883484 49.99416
## 1551 5.889726 49.99597
## 1552 5.893557 49.99723
## 1553 5.895626 49.99768
## 1554 5.898928 49.99794
## 1555 5.905029 49.99790
## 1556 5.907912 49.99907
## 1557 5.910076 50.00015
## 1558 5.912067 50.00143
## 1559 5.913689 50.00289
## 1560 5.914094 50.00344
## 1561 5.914629 50.00459
## 1562 5.914912 50.00578
## 1563 5.915471 50.00941
## 1564 5.915893 50.01058
## 1565 5.916216 50.01114
## 1566 5.916640 50.01168
## 1567 5.917689 50.01266
## 1568 5.920723 50.01491
## 1569 5.921820 50.01584
## 1570 5.922277 50.01635
## 1571 5.922839 50.01738
## 1572 5.922953 50.01839
## 1573 5.922867 50.01890
## 1574 5.922341 50.01996
## 1575 5.921389 50.02097
## 1576 5.917307 50.02420
## 1577 5.916834 50.02470
## 1578 5.916232 50.02576
## 1579 5.916082 50.02678
## 1580 5.916355 50.02781
## 1581 5.916735 50.02837
## 1582 5.917842 50.02931
## 1583 5.919308 50.02999
## 1584 5.920168 50.03021
## 1585 5.921710 50.03033
## 1586 5.923222 50.03017
## 1587 5.923949 50.02999
## 1588 5.925479 50.02936
## 1589 5.930055 50.02644
## 1590 5.931502 50.02573
## 1591 5.932308 50.02546
## 1592 5.933780 50.02520
## 1593 5.935290 50.02517
## 1594 5.936038 50.02525
## 1595 5.937686 50.02563
## 1596 5.940761 50.02668
## 1597 5.943525 50.02743
## 1598 5.945063 50.02798
## 1599 5.947434 50.02916
```

```
## 1600 5.953403 50.03279
## 1601 5.955709 50.03409
## 1602 5.957327 50.03486
## 1603 5.961040 50.03632
## 1604 5.963571 50.03564
## 1605 5.968068 50.03463
## 1606 5.968933 50.03435
## 1607 5.970414 50.03364
## 1608 5.971668 50.03277
## 1609 5.972670 50.03177
## 1610 5.974165 50.02949
## 1611 5.975572 50.02795
## 1612 5.977929 50.02602
##
##
##
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   5.914545 49.938918
##
## Slot "ID":
## [1] "5"
##
## Slot "area":
## [1] 0.03295997
##
##
## [[6]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   6.378449 49.785109
##
## Slot "area":
## [1] 0.02350635
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##             x        y
## 1613 6.385532 49.83703
## 1614 6.388600 49.83368
## 1615 6.390184 49.83195
## 1616 6.395162 49.82735
## 1617 6.397452 49.82360
## 1618 6.405219 49.81997
```

```
## 1619 6.415373 49.81821
## 1620 6.424975 49.81713
## 1621 6.432136 49.81520
## 1622 6.443452 49.81495
## 1623 6.447955 49.81307
## 1624 6.450050 49.81320
## 1625 6.452540 49.81510
## 1626 6.460710 49.82133
## 1627 6.472089 49.82205
## 1628 6.478120 49.81872
## 1629 6.478250 49.81740
## 1630 6.478480 49.81502
## 1631 6.484520 49.81169
## 1632 6.495890 49.81241
## 1633 6.501930 49.80908
## 1634 6.502290 49.80538
## 1635 6.507970 49.80574
## 1636 6.508330 49.80204
## 1637 6.511578 49.80451
## 1638 6.512384 49.80325
## 1639 6.517581 49.80575
## 1640 6.521836 49.80972
## 1641 6.524343 49.81309
## 1642 6.524464 49.81295
## 1643 6.528252 49.80857
## 1644 6.524607 49.80254
## 1645 6.517797 49.79646
## 1646 6.511163 49.79439
## 1647 6.506937 49.79007
## 1648 6.512703 49.78731
## 1649 6.517733 49.78511
## 1650 6.513895 49.77988
## 1651 6.515247 49.77291
## 1652 6.517755 49.76889
## 1653 6.518084 49.76837
## 1654 6.518823 49.76368
## 1655 6.515122 49.75903
## 1656 6.509757 49.75641
## 1657 6.504398 49.75391
## 1658 6.501966 49.74848
## 1659 6.503288 49.74231
## 1660 6.506682 49.73721
## 1661 6.510579 49.73499
## 1662 6.507915 49.73478
## 1663 6.499222 49.73478
## 1664 6.497910 49.73478
## 1665 6.497960 49.73430
## 1666 6.502380 49.73188
## 1667 6.501184 49.73172
## 1668 6.497560 49.73191
## 1669 6.494325 49.73257
## 1670 6.478621 49.73719
## 1671 6.475485 49.73763
## 1672 6.471368 49.73750
```

```
## 1673 6.464350 49.73973
## 1674 6.457753 49.74200
## 1675 6.456916 49.74221
## 1676 6.455417 49.74240
## 1677 6.453892 49.74237
## 1678 6.453137 49.74226
## 1679 6.451485 49.74177
## 1680 6.449276 49.74068
## 1681 6.446520 49.73896
## 1682 6.443896 49.73711
## 1683 6.442689 49.73615
## 1684 6.441630 49.73515
## 1685 6.440869 49.73417
## 1686 6.440011 49.73281
## 1687 6.439194 49.73186
## 1688 6.438025 49.73095
## 1689 6.437345 49.73056
## 1690 6.435781 49.72993
## 1691 6.434113 49.72963
## 1692 6.432395 49.72955
## 1693 6.430670 49.72964
## 1694 6.429815 49.72976
## 1695 6.428151 49.73015
## 1696 6.427332 49.73046
## 1697 6.426570 49.73082
## 1698 6.425158 49.73164
## 1699 6.423176 49.73302
## 1700 6.414771 49.73930
## 1701 6.405591 49.74598
## 1702 6.402157 49.74825
## 1703 6.398983 49.75002
## 1704 6.392127 49.75016
## 1705 6.390150 49.75007
## 1706 6.388219 49.74978
## 1707 6.386529 49.74925
## 1708 6.384995 49.74855
## 1709 6.383589 49.74775
## 1710 6.382319 49.74686
## 1711 6.381239 49.74588
## 1712 6.380805 49.74536
## 1713 6.380472 49.74479
## 1714 6.380193 49.74354
## 1715 6.380429 49.74232
## 1716 6.382352 49.73925
## 1717 6.382562 49.73804
## 1718 6.382260 49.73681
## 1719 6.381933 49.73627
## 1720 6.381028 49.73528
## 1721 6.376956 49.73200
## 1722 6.372849 49.73165
## 1723 6.369778 49.73153
## 1724 6.365691 49.73156
## 1725 6.361629 49.73173
## 1726 6.358655 49.73196
```

```
## 1727 6.356759 49.73219
## 1728 6.354997 49.73254
## 1729 6.352794 49.73317
## 1730 6.351339 49.73348
## 1731 6.350568 49.73352
## 1732 6.349721 49.73344
## 1733 6.348123 49.73301
## 1734 6.343495 49.73089
## 1735 6.341784 49.73030
## 1736 6.339985 49.72994
## 1737 6.335334 49.72932
## 1738 6.333520 49.72885
## 1739 6.330997 49.72776
## 1740 6.322535 49.72324
## 1741 6.318734 49.72663
## 1742 6.314657 49.72972
## 1743 6.311735 49.73157
## 1744 6.310134 49.73234
## 1745 6.309276 49.73265
## 1746 6.307462 49.73309
## 1747 6.303752 49.73369
## 1748 6.301950 49.73410
## 1749 6.300357 49.73465
## 1750 6.297281 49.73588
## 1751 6.293863 49.73696
## 1752 6.290008 49.73849
## 1753 6.288266 49.73896
## 1754 6.285379 49.73935
## 1755 6.278389 49.73971
## 1756 6.275429 49.73996
## 1757 6.273525 49.74028
## 1758 6.267931 49.74177
## 1759 6.272850 49.74482
## 1760 6.274911 49.74594
## 1761 6.276438 49.74663
## 1762 6.274765 49.75032
## 1763 6.274490 49.75150
## 1764 6.274494 49.75213
## 1765 6.274601 49.75275
## 1766 6.275109 49.75390
## 1767 6.276655 49.75596
## 1768 6.277303 49.75710
## 1769 6.277864 49.75903
## 1770 6.278229 49.76171
## 1771 6.274656 49.76431
## 1772 6.273339 49.76538
## 1773 6.272174 49.76651
## 1774 6.271278 49.76772
## 1775 6.270985 49.76833
## 1776 6.269970 49.77212
## 1777 6.269285 49.77337
## 1778 6.267643 49.77509
## 1779 6.265579 49.77662
## 1780 6.264008 49.77750
```

```
## 1781 6.263153 49.77787
## 1782 6.262240 49.77819
## 1783 6.260350 49.77858
## 1784 6.257408 49.77883
## 1785 6.250473 49.77905
## 1786 6.248562 49.77927
## 1787 6.246745 49.77971
## 1788 6.245248 49.78041
## 1789 6.244043 49.78131
## 1790 6.243560 49.78182
## 1791 6.242877 49.78296
## 1792 6.242424 49.78479
## 1793 6.244751 49.78669
## 1794 6.245669 49.78773
## 1795 6.246308 49.78895
## 1796 6.247147 49.79145
## 1797 6.247712 49.79268
## 1798 6.248500 49.79375
## 1799 6.250278 49.79582
## 1800 6.251447 49.79754
## 1801 6.252364 49.79863
## 1802 6.253468 49.79960
## 1803 6.257137 49.80239
## 1804 6.258237 49.80337
## 1805 6.260425 49.80613
## 1806 6.261525 49.80719
## 1807 6.263498 49.80866
## 1808 6.269167 49.81242
## 1809 6.270946 49.81399
## 1810 6.271406 49.81457
## 1811 6.272037 49.81581
## 1812 6.272968 49.81944
## 1813 6.264539 49.82555
## 1814 6.263139 49.82684
## 1815 6.262528 49.82780
## 1816 6.262432 49.82833
## 1817 6.262534 49.82886
## 1818 6.262798 49.82936
## 1819 6.263642 49.83028
## 1820 6.267006 49.83296
## 1821 6.267947 49.83398
## 1822 6.268550 49.83505
## 1823 6.269528 49.83784
## 1824 6.270054 49.83893
## 1825 6.270860 49.84001
## 1826 6.272662 49.84208
## 1827 6.274245 49.84437
## 1828 6.275156 49.84532
## 1829 6.276210 49.84625
## 1830 6.281958 49.84485
## 1831 6.284100 49.84450
## 1832 6.286313 49.84428
## 1833 6.290839 49.84404
## 1834 6.303394 49.84359
```

```
## 1835 6.306700 49.84364
## 1836 6.308823 49.84388
## 1837 6.309841 49.84412
## 1838 6.311388 49.84475
## 1839 6.312673 49.84557
## 1840 6.313209 49.84605
## 1841 6.314039 49.84713
## 1842 6.315490 49.85073
## 1843 6.315773 49.85115
## 1844 6.316730 49.85063
## 1845 6.316876 49.84919
## 1846 6.317110 49.84692
## 1847 6.311520 49.84294
## 1848 6.312281 49.83550
## 1849 6.330179 49.83639
## 1850 6.329789 49.84009
## 1851 6.332004 49.84168
## 1852 6.333697 49.84174
## 1853 6.335414 49.84180
## 1854 6.337848 49.84666
## 1855 6.339241 49.84801
## 1856 6.342431 49.85111
## 1857 6.351377 49.85266
## 1858 6.362998 49.85403
## 1859 6.370845 49.85269
## 1860 6.375780 49.84923
## 1861 6.381573 49.84235
## 1862 6.385532 49.83703
##
##
##
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   6.378449 49.785109
##
## Slot "ID":
## [1] "6"
##
## Slot "area":
## [1] 0.02350635
##
##
## [[7]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   6.311601 49.545695
##
## Slot "area":
## [1] 0.016026
```

```
## 
## Slot "hole":
## [1] FALSE
## 
## Slot "ringDir":
## [1] 1
## 
## Slot "coords":
##               x        y
## 1863 6.316665 49.62337
## 1864 6.318350 49.62316
## 1865 6.320131 49.62317
## 1866 6.320980 49.62326
## 1867 6.323852 49.62390
## 1868 6.324579 49.62400
## 1869 6.325347 49.62401
## 1870 6.326158 49.62390
## 1871 6.327678 49.62338
## 1872 6.329097 49.62263
## 1873 6.331148 49.62128
## 1874 6.334522 49.61877
## 1875 6.337147 49.61668
## 1876 6.338948 49.61507
## 1877 6.339962 49.61398
## 1878 6.341337 49.61173
## 1879 6.342146 49.61071
## 1880 6.343228 49.60990
## 1881 6.344570 49.60934
## 1882 6.345335 49.60920
## 1883 6.346106 49.60919
## 1884 6.346835 49.60928
## 1885 6.349716 49.61000
## 1886 6.352423 49.61034
## 1887 6.355366 49.61045
## 1888 6.360396 49.61051
## 1889 6.363362 49.61066
## 1890 6.366712 49.60901
## 1891 6.368299 49.60812
## 1892 6.371259 49.60622
## 1893 6.374022 49.60421
## 1894 6.375274 49.60315
## 1895 6.376342 49.60202
## 1896 6.377074 49.60077
## 1897 6.377429 49.59946
## 1898 6.377514 49.59750
## 1899 6.377325 49.59624
## 1900 6.376865 49.59506
## 1901 6.376483 49.59452
## 1902 6.375960 49.59404
## 1903 6.375309 49.59365
## 1904 6.373841 49.59311
## 1905 6.370027 49.59194
## 1906 6.366523 49.59103
## 1907 6.370787 49.58933
```

```
## 1908 6.373098 49.58854
## 1909 6.375193 49.58806
## 1910 6.379423 49.58730
## 1911 6.380447 49.58699
## 1912 6.381701 49.58345
## 1913 6.380666 49.58038
## 1914 6.381309 49.57427
## 1915 6.375429 49.57396
## 1916 6.369699 49.57369
## 1917 6.369337 49.57734
## 1918 6.366857 49.57697
## 1919 6.363648 49.57405
## 1920 6.366681 49.56918
## 1921 6.370531 49.56523
## 1922 6.371294 49.56445
## 1923 6.376156 49.56190
## 1924 6.379465 49.55864
## 1925 6.378998 49.55336
## 1926 6.377845 49.55166
## 1927 6.378159 49.54800
## 1928 6.375356 49.54800
## 1929 6.371420 49.54801
## 1930 6.371500 49.54476
## 1931 6.371509 49.54437
## 1932 6.369979 49.54353
## 1933 6.364860 49.53944
## 1934 6.360836 49.53512
## 1935 6.359809 49.53189
## 1936 6.359445 49.53074
## 1937 6.360380 49.52560
## 1938 6.367354 49.52700
## 1939 6.372539 49.50921
## 1940 6.364920 49.50689
## 1941 6.367446 49.49711
## 1942 6.367456 49.49707
## 1943 6.366579 49.48926
## 1944 6.364990 49.48190
## 1945 6.364831 49.47731
## 1946 6.366289 49.46839
## 1947 6.360238 49.46542
## 1948 6.359714 49.46516
## 1949 6.354821 49.46498
## 1950 6.351248 49.46704
## 1951 6.347110 49.46603
## 1952 6.343426 49.46838
## 1953 6.334386 49.46699
## 1954 6.333777 49.46689
## 1955 6.332460 49.46786
## 1956 6.324391 49.47377
## 1957 6.324320 49.47383
## 1958 6.324293 49.47385
## 1959 6.323873 49.47416
## 1960 6.319861 49.47710
## 1961 6.300350 49.48082
```

```
## 1962 6.297490 49.48136
## 1963 6.295625 49.48172
## 1964 6.296607 49.48349
## 1965 6.299231 49.48821
## 1966 6.289472 49.48697
## 1967 6.280569 49.49416
## 1968 6.279777 49.49584
## 1969 6.278474 49.49861
## 1970 6.277791 49.50016
## 1971 6.277751 49.50014
## 1972 6.276154 49.50354
## 1973 6.243451 49.51199
## 1974 6.242694 49.51218
## 1975 6.236431 49.50853
## 1976 6.234734 49.52286
## 1977 6.229656 49.53640
## 1978 6.225736 49.53991
## 1979 6.224969 49.54195
## 1980 6.224690 49.54342
## 1981 6.224127 49.54921
## 1982 6.223753 49.55052
## 1983 6.222847 49.55256
## 1984 6.222746 49.55359
## 1985 6.222929 49.55415
## 1986 6.223691 49.55519
## 1987 6.227653 49.55867
## 1988 6.228115 49.55925
## 1989 6.228784 49.56056
## 1990 6.229163 49.56195
## 1991 6.229439 49.56411
## 1992 6.229596 49.56999
## 1993 6.233290 49.57053
## 1994 6.237329 49.57169
## 1995 6.239093 49.57205
## 1996 6.241001 49.57224
## 1997 6.248813 49.57257
## 1998 6.255628 49.57359
## 1999 6.256813 49.57601
## 2000 6.258920 49.57907
## 2001 6.259897 49.57989
## 2002 6.261506 49.58091
## 2003 6.263268 49.58271
## 2004 6.264348 49.58359
## 2005 6.265640 49.58438
## 2006 6.267111 49.58504
## 2007 6.270509 49.58602
## 2008 6.274468 49.58731
## 2009 6.276268 49.58765
## 2010 6.278193 49.58775
## 2011 6.280115 49.58765
## 2012 6.281970 49.58738
## 2013 6.283626 49.58690
## 2014 6.285805 49.58604
## 2015 6.287336 49.58555
```

```
## 2016 6.289138 49.58532
## 2017 6.290998 49.58545
## 2018 6.291826 49.58564
## 2019 6.293354 49.58620
## 2020 6.295424 49.58735
## 2021 6.297971 49.58923
## 2022 6.300440 49.59150
## 2023 6.298118 49.59360
## 2024 6.296133 49.59486
## 2025 6.294579 49.59554
## 2026 6.292084 49.59639
## 2027 6.289014 49.59760
## 2028 6.287377 49.59811
## 2029 6.285508 49.59846
## 2030 6.283574 49.59863
## 2031 6.280721 49.59872
## 2032 6.280143 49.60043
## 2033 6.279864 49.60168
## 2034 6.279746 49.60303
## 2035 6.279808 49.60437
## 2036 6.280098 49.60567
## 2037 6.280363 49.60630
## 2038 6.280738 49.60691
## 2039 6.281749 49.60791
## 2040 6.282362 49.60834
## 2041 6.283734 49.60907
## 2042 6.285294 49.60962
## 2043 6.287743 49.61032
## 2044 6.288479 49.61061
## 2045 6.289848 49.61133
## 2046 6.291037 49.61219
## 2047 6.291541 49.61267
## 2048 6.293240 49.61486
## 2049 6.294242 49.61586
## 2050 6.296057 49.61725
## 2051 6.298102 49.61852
## 2052 6.299570 49.61926
## 2053 6.301128 49.61988
## 2054 6.304585 49.62084
## 2055 6.306120 49.62141
## 2056 6.310536 49.62347
## 2057 6.312236 49.62416
## 2058 6.316665 49.62337
##
##
##
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   6.311601 49.545695
##
## Slot "ID":
## [1] "7"
```

```
##
## Slot "area":
## [1] 0.016026
##
##
## [[8]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   6.346395 49.687418
##
## Slot "area":
## [1] 0.02620982
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##              x        y
## 2059 6.425158 49.73164
## 2060 6.426570 49.73082
## 2061 6.427332 49.73046
## 2062 6.428151 49.73015
## 2063 6.429815 49.72976
## 2064 6.430670 49.72964
## 2065 6.432395 49.72955
## 2066 6.434113 49.72963
## 2067 6.435781 49.72993
## 2068 6.437345 49.73056
## 2069 6.438025 49.73095
## 2070 6.439194 49.73186
## 2071 6.440011 49.73281
## 2072 6.440869 49.73417
## 2073 6.441630 49.73515
## 2074 6.442689 49.73615
## 2075 6.443896 49.73711
## 2076 6.446520 49.73896
## 2077 6.449276 49.74068
## 2078 6.451485 49.74177
## 2079 6.453137 49.74226
## 2080 6.453892 49.74237
## 2081 6.455417 49.74240
## 2082 6.456916 49.74221
## 2083 6.457753 49.74200
## 2084 6.464350 49.73973
## 2085 6.471368 49.73750
## 2086 6.475485 49.73763
## 2087 6.478621 49.73719
## 2088 6.494325 49.73257
```

```
## 2089 6.497560 49.73191
## 2090 6.501184 49.73172
## 2091 6.502380 49.73188
## 2092 6.516485 49.72418
## 2093 6.512013 49.72378
## 2094 6.511858 49.72390
## 2095 6.507083 49.72771
## 2096 6.500683 49.72897
## 2097 6.498479 49.72688
## 2098 6.497116 49.72558
## 2099 6.499993 49.72012
## 2100 6.501064 49.71864
## 2101 6.503183 49.71571
## 2102 6.501830 49.71473
## 2103 6.496845 49.71113
## 2104 6.489582 49.70354
## 2105 6.481972 49.69985
## 2106 6.476208 49.69788
## 2107 6.473040 49.69549
## 2108 6.467570 49.69515
## 2109 6.461548 49.69477
## 2110 6.461765 49.69262
## 2111 6.461920 49.69107
## 2112 6.459641 49.69093
## 2113 6.457063 49.68778
## 2114 6.456425 49.68700
## 2115 6.453407 49.68340
## 2116 6.449514 49.67965
## 2117 6.442267 49.67585
## 2118 6.440990 49.67519
## 2119 6.440500 49.67482
## 2120 6.439434 49.67439
## 2121 6.429440 49.67038
## 2122 6.424100 49.66633
## 2123 6.424829 49.65893
## 2124 6.436261 49.65965
## 2125 6.436368 49.65858
## 2126 6.437000 49.65225
## 2127 6.421670 49.63266
## 2128 6.422377 49.62557
## 2129 6.422409 49.62524
## 2130 6.421841 49.62481
## 2131 6.419111 49.62130
## 2132 6.417171 49.61997
## 2133 6.417420 49.61749
## 2134 6.412059 49.61343
## 2135 6.406341 49.61307
## 2136 6.403597 49.61098
## 2137 6.403202 49.61057
## 2138 6.400891 49.60708
## 2139 6.398603 49.60529
## 2140 6.396000 49.60124
## 2141 6.390619 49.59719
## 2142 6.379267 49.59655
```

```
## 2143 6.376737 49.59218
## 2144 6.380288 49.58744
## 2145 6.380447 49.58699
## 2146 6.379423 49.58730
## 2147 6.375193 49.58806
## 2148 6.373098 49.58854
## 2149 6.370787 49.58933
## 2150 6.366523 49.59103
## 2151 6.370027 49.59194
## 2152 6.373841 49.59311
## 2153 6.375309 49.59365
## 2154 6.375960 49.59404
## 2155 6.376483 49.59452
## 2156 6.376865 49.59506
## 2157 6.377325 49.59624
## 2158 6.377514 49.59750
## 2159 6.377429 49.59946
## 2160 6.377074 49.60077
## 2161 6.376342 49.60202
## 2162 6.375274 49.60315
## 2163 6.374022 49.60421
## 2164 6.371259 49.60622
## 2165 6.368299 49.60812
## 2166 6.366712 49.60901
## 2167 6.363362 49.61066
## 2168 6.360396 49.61051
## 2169 6.355366 49.61045
## 2170 6.352423 49.61034
## 2171 6.349716 49.61000
## 2172 6.346835 49.60928
## 2173 6.346106 49.60919
## 2174 6.345335 49.60920
## 2175 6.344570 49.60934
## 2176 6.343228 49.60990
## 2177 6.342146 49.61071
## 2178 6.341337 49.61173
## 2179 6.339962 49.61398
## 2180 6.338948 49.61507
## 2181 6.337147 49.61668
## 2182 6.334522 49.61877
## 2183 6.331148 49.62128
## 2184 6.329097 49.62263
## 2185 6.327678 49.62338
## 2186 6.326158 49.62390
## 2187 6.325347 49.62401
## 2188 6.324579 49.62400
## 2189 6.323852 49.62390
## 2190 6.320980 49.62326
## 2191 6.320131 49.62317
## 2192 6.318350 49.62316
## 2193 6.316665 49.62337
## 2194 6.312236 49.62416
## 2195 6.311212 49.62632
## 2196 6.309954 49.62854
```

```
## 2197 6.308840 49.63102
## 2198 6.306924 49.63439
## 2199 6.303422 49.63422
## 2200 6.300601 49.63430
## 2201 6.298713 49.63458
## 2202 6.297016 49.63514
## 2203 6.295623 49.63591
## 2204 6.294486 49.63685
## 2205 6.293612 49.63792
## 2206 6.292144 49.64018
## 2207 6.289577 49.64277
## 2208 6.287457 49.64478
## 2209 6.286650 49.64589
## 2210 6.286339 49.64656
## 2211 6.285910 49.64865
## 2212 6.285731 49.65436
## 2213 6.285392 49.65575
## 2214 6.285086 49.65642
## 2215 6.284200 49.65763
## 2216 6.280656 49.66092
## 2217 6.279142 49.66266
## 2218 6.278515 49.66389
## 2219 6.276807 49.66806
## 2220 6.274529 49.67044
## 2221 6.270432 49.67386
## 2222 6.268538 49.67560
## 2223 6.267510 49.67679
## 2224 6.265994 49.67905
## 2225 6.264989 49.68004
## 2226 6.263733 49.68090
## 2227 6.263013 49.68127
## 2228 6.261275 49.68187
## 2229 6.258232 49.68233
## 2230 6.255049 49.68250
## 2231 6.223391 49.68326
## 2232 6.220201 49.68314
## 2233 6.218142 49.68288
## 2234 6.213029 49.68165
## 2235 6.208783 49.68438
## 2236 6.207196 49.68527
## 2237 6.205440 49.68599
## 2238 6.204519 49.68624
## 2239 6.202607 49.68656
## 2240 6.200649 49.68672
## 2241 6.198678 49.68676
## 2242 6.195755 49.68660
## 2243 6.193887 49.68629
## 2244 6.189885 49.68505
## 2245 6.188135 49.68465
## 2246 6.185239 49.68437
## 2247 6.181246 49.68432
## 2248 6.177268 49.68455
## 2249 6.174397 49.68502
## 2250 6.173491 49.68528
```

```
## 2251 6.171922 49.68592
## 2252 6.169137 49.68753
## 2253 6.169600 49.68877
## 2254 6.170257 49.68998
## 2255 6.171889 49.69164
## 2256 6.173239 49.69262
## 2257 6.175444 49.69393
## 2258 6.179755 49.69590
## 2259 6.180346 49.69628
## 2260 6.181247 49.69736
## 2261 6.181730 49.69862
## 2262 6.182036 49.70069
## 2263 6.182207 49.70880
## 2264 6.182539 49.71246
## 2265 6.183110 49.71456
## 2266 6.184645 49.71807
## 2267 6.187962 49.71759
## 2268 6.189631 49.71742
## 2269 6.192597 49.71739
## 2270 6.194528 49.71766
## 2271 6.195390 49.71790
## 2272 6.196973 49.71854
## 2273 6.198415 49.71932
## 2274 6.200356 49.72065
## 2275 6.201940 49.72217
## 2276 6.202659 49.72334
## 2277 6.203899 49.72703
## 2278 6.204256 49.72762
## 2279 6.205223 49.72861
## 2280 6.205818 49.72905
## 2281 6.207170 49.72981
## 2282 6.208741 49.73038
## 2283 6.212083 49.73136
## 2284 6.214426 49.73243
## 2285 6.218154 49.73456
## 2286 6.226870 49.74000
## 2287 6.229571 49.74188
## 2288 6.231256 49.74343
## 2289 6.232029 49.74459
## 2290 6.232690 49.74645
## 2291 6.252104 49.74599
## 2292 6.257681 49.74563
## 2293 6.259820 49.74529
## 2294 6.261834 49.74469
## 2295 6.267931 49.74177
## 2296 6.273525 49.74028
## 2297 6.275429 49.73996
## 2298 6.278389 49.73971
## 2299 6.285379 49.73935
## 2300 6.288266 49.73896
## 2301 6.290008 49.73849
## 2302 6.293863 49.73696
## 2303 6.297281 49.73588
## 2304 6.300357 49.73465
```

```
## 2305 6.301950 49.73410
## 2306 6.303752 49.73369
## 2307 6.307462 49.73309
## 2308 6.309276 49.73265
## 2309 6.310134 49.73234
## 2310 6.311735 49.73157
## 2311 6.314657 49.72972
## 2312 6.318734 49.72663
## 2313 6.322535 49.72324
## 2314 6.330997 49.72776
## 2315 6.333520 49.72885
## 2316 6.335334 49.72932
## 2317 6.339985 49.72994
## 2318 6.341784 49.73030
## 2319 6.343495 49.73089
## 2320 6.348123 49.73301
## 2321 6.349721 49.73344
## 2322 6.350568 49.73352
## 2323 6.351339 49.73348
## 2324 6.352794 49.73317
## 2325 6.354997 49.73254
## 2326 6.356759 49.73219
## 2327 6.358655 49.73196
## 2328 6.361629 49.73173
## 2329 6.365691 49.73156
## 2330 6.369778 49.73153
## 2331 6.372849 49.73165
## 2332 6.376956 49.73200
## 2333 6.381028 49.73528
## 2334 6.381933 49.73627
## 2335 6.382260 49.73681
## 2336 6.382562 49.73804
## 2337 6.382352 49.73925
## 2338 6.380429 49.74232
## 2339 6.380193 49.74354
## 2340 6.380472 49.74479
## 2341 6.380805 49.74536
## 2342 6.381239 49.74588
## 2343 6.382319 49.74686
## 2344 6.383589 49.74775
## 2345 6.384995 49.74855
## 2346 6.386529 49.74925
## 2347 6.388219 49.74978
## 2348 6.390150 49.75007
## 2349 6.392127 49.75016
## 2350 6.398983 49.75002
## 2351 6.402157 49.74825
## 2352 6.405591 49.74598
## 2353 6.414771 49.73930
## 2354 6.423176 49.73302
## 2355 6.425158 49.73164
##
##
##
```

```
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   6.346395 49.687418
##
## Slot "ID":
## [1] "8"
##
## Slot "area":
## [1] 0.02620982
##
##
## [[9]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   5.963503 49.641589
##
## Slot "area":
## [1] 0.02310772
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##               x          y
## 2356 5.998312 49.69992
## 2357 5.998632 49.69856
## 2358 5.998956 49.69790
## 2359 5.999366 49.69733
## 2360 6.000454 49.69633
## 2361 6.001845 49.69551
## 2362 6.003561 49.69493
## 2363 6.005455 49.69463
## 2364 6.007399 49.69451
## 2365 6.010342 49.69455
## 2366 6.013215 49.69485
## 2367 6.014944 49.69525
## 2368 6.018064 49.69619
## 2369 6.019788 49.69648
## 2370 6.020710 49.69651
## 2371 6.021638 49.69649
## 2372 6.023353 49.69626
## 2373 6.028385 49.69516
## 2374 6.029469 49.69543
## 2375 6.030759 49.69553
## 2376 6.031482 49.69543
## 2377 6.032184 49.69523
```

```
## 2378 6.033527 49.69463
## 2379 6.036830 49.69267
## 2380 6.038293 49.69193
## 2381 6.039097 49.69162
## 2382 6.040802 49.69118
## 2383 6.042593 49.69092
## 2384 6.045341 49.69075
## 2385 6.047178 49.69075
## 2386 6.048995 49.69088
## 2387 6.050760 49.69119
## 2388 6.051601 49.69145
## 2389 6.053151 49.69210
## 2390 6.054587 49.69287
## 2391 6.057274 49.69460
## 2392 6.059139 49.69598
## 2393 6.060259 49.69695
## 2394 6.061389 49.69818
## 2395 6.067792 49.69626
## 2396 6.070677 49.69580
## 2397 6.073648 49.69562
## 2398 6.076608 49.69566
## 2399 6.078523 49.69585
## 2400 6.080274 49.69622
## 2401 6.084118 49.69739
## 2402 6.085760 49.69769
## 2403 6.088757 49.69486
## 2404 6.091182 49.69296
## 2405 6.093895 49.69119
## 2406 6.097388 49.68937
## 2407 6.095214 49.68855
## 2408 6.093812 49.68795
## 2409 6.091721 49.68683
## 2410 6.090426 49.68600
## 2411 6.089242 49.68514
## 2412 6.086576 49.68293
## 2413 6.086965 49.68141
## 2414 6.087452 49.67811
## 2415 6.087778 49.67682
## 2416 6.088335 49.67562
## 2417 6.090090 49.67286
## 2418 6.090551 49.67162
## 2419 6.091230 49.66909
## 2420 6.091802 49.66785
## 2421 6.092777 49.66664
## 2422 6.094027 49.66554
## 2423 6.096207 49.66405
## 2424 6.098376 49.66285
## 2425 6.098635 49.65900
## 2426 6.098623 49.65579
## 2427 6.098402 49.65097
## 2428 6.098135 49.64813
## 2429 6.094454 49.64828
## 2430 6.093455 49.64835
## 2431 6.092918 49.64842
```

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## 2432 6.092623 49.64851
## 2433 6.092213 49.64872
## 2434 6.092074 49.64877
## 2435 6.091747 49.64884
## 2436 6.091379 49.64888
## 2437 6.090378 49.64894
## 2438 6.086421 49.64911
## 2439 6.085182 49.64917
## 2440 6.084582 49.64923
## 2441 6.084204 49.64930
## 2442 6.083881 49.64939
## 2443 6.083332 49.64958
## 2444 6.083017 49.64965
## 2445 6.082669 49.64966
## 2446 6.082492 49.64965
## 2447 6.082204 49.64957
## 2448 6.082287 49.65054
## 2449 6.082206 49.65186
## 2450 6.081880 49.65316
## 2451 6.081566 49.65379
## 2452 6.080655 49.65487
## 2453 6.079418 49.65579
## 2454 6.078691 49.65617
## 2455 6.076902 49.65679
## 2456 6.074840 49.65712
## 2457 6.072717 49.65725
## 2458 6.069495 49.65718
## 2459 6.067373 49.65695
## 2460 6.065530 49.65653
## 2461 6.060824 49.65483
## 2462 6.059399 49.65334
## 2463 6.056826 49.65100
## 2464 6.055744 49.64975
## 2465 6.053014 49.64676
## 2466 6.049973 49.64369
## 2467 6.048382 49.64141
## 2468 6.046631 49.63935
## 2469 6.045855 49.63825
## 2470 6.045313 49.63698
## 2471 6.045000 49.63564
## 2472 6.044160 49.62835
## 2473 6.041666 49.62754
## 2474 6.040011 49.62691
## 2475 6.037783 49.62577
## 2476 6.035740 49.62448
## 2477 6.034499 49.62355
## 2478 6.033406 49.62257
## 2479 6.032517 49.62149
## 2480 6.031343 49.61977
## 2481 6.029699 49.61817
## 2482 6.027712 49.61668
## 2483 6.025573 49.61526
## 2484 6.023348 49.61391
## 2485 6.021015 49.61269
```

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## 2486 6.019350 49.61203
## 2487 6.015864 49.61111
## 2488 6.012712 49.61005
## 2489 6.011065 49.60958
## 2490 6.009204 49.60929
## 2491 6.004432 49.60890
## 2492 6.001067 49.60838
## 2493 5.998247 49.60806
## 2494 5.999035 49.60324
## 2495 5.999454 49.60194
## 2496 5.999782 49.60131
## 2497 6.000719 49.60014
## 2498 6.001897 49.59906
## 2499 6.006519 49.59562
## 2500 6.007680 49.59465
## 2501 6.008580 49.59362
## 2502 6.008872 49.59307
## 2503 6.009007 49.59251
## 2504 6.008788 49.59147
## 2505 6.007341 49.58893
## 2506 6.005917 49.58376
## 2507 6.004476 49.58069
## 2508 6.000514 49.57792
## 2509 5.989211 49.57056
## 2510 5.986956 49.56938
## 2511 5.985270 49.56879
## 2512 5.984435 49.56862
## 2513 5.982724 49.56845
## 2514 5.980999 49.56847
## 2515 5.979294 49.56866
## 2516 5.977658 49.56906
## 2517 5.976855 49.56937
## 2518 5.975402 49.57012
## 2519 5.971421 49.57271
## 2520 5.969965 49.57346
## 2521 5.968353 49.57399
## 2522 5.966671 49.57426
## 2523 5.964091 49.57433
## 2524 5.962393 49.57415
## 2525 5.961572 49.57396
## 2526 5.959974 49.57338
## 2527 5.957160 49.57184
## 2528 5.953001 49.56919
## 2529 5.950071 49.56776
## 2530 5.948456 49.56722
## 2531 5.947541 49.56703
## 2532 5.945648 49.56681
## 2533 5.939844 49.56659
## 2534 5.937945 49.56638
## 2535 5.937023 49.56620
## 2536 5.936190 49.56596
## 2537 5.934631 49.56533
## 2538 5.930302 49.56307
## 2539 5.928813 49.56238
```

```
## 2540 5.927178 49.56181
## 2541 5.924589 49.56111
## 2542 5.921437 49.56005
## 2543 5.919777 49.55960
## 2544 5.918848 49.55944
## 2545 5.916933 49.55928
## 2546 5.910085 49.55910
## 2547 5.908175 49.55882
## 2548 5.906504 49.55830
## 2549 5.905001 49.55762
## 2550 5.903062 49.55640
## 2551 5.902052 49.55549
## 2552 5.901433 49.55447
## 2553 5.901356 49.55391
## 2554 5.901482 49.55336
## 2555 5.901762 49.55286
## 2556 5.902591 49.55198
## 2557 5.903587 49.55115
## 2558 5.901442 49.55005
## 2559 5.899906 49.54942
## 2560 5.899079 49.54918
## 2561 5.897228 49.54884
## 2562 5.895303 49.54870
## 2563 5.892354 49.54874
## 2564 5.890378 49.54889
## 2565 5.887289 49.54927
## 2566 5.887873 49.56132
## 2567 5.887583 49.56355
## 2568 5.886944 49.56493
## 2569 5.886430 49.56551
## 2570 5.885111 49.56645
## 2571 5.883536 49.56698
## 2572 5.879776 49.56701
## 2573 5.878969 49.56715
## 2574 5.877327 49.56771
## 2575 5.872277 49.57021
## 2576 5.868159 49.57189
## 2577 5.870666 49.57383
## 2578 5.874457 49.57677
## 2579 5.874348 49.58174
## 2580 5.874229 49.58715
## 2581 5.868424 49.58627
## 2582 5.868544 49.58684
## 2583 5.862429 49.58829
## 2584 5.852082 49.59076
## 2585 5.852911 49.59372
## 2586 5.853985 49.59756
## 2587 5.861946 49.60175
## 2588 5.866229 49.60368
## 2589 5.871145 49.60591
## 2590 5.870852 49.60912
## 2591 5.870452 49.61349
## 2592 5.870654 49.61380
## 2593 5.874896 49.62020
```

```
## 2594 5.881650 49.62652
## 2595 5.881381 49.62811
## 2596 5.880709 49.63206
## 2597 5.880622 49.63258
## 2598 5.884277 49.63866
## 2599 5.897291 49.63915
## 2600 5.898845 49.63921
## 2601 5.907087 49.63952
## 2602 5.907876 49.64690
## 2603 5.906943 49.65457
## 2604 5.908158 49.65912
## 2605 5.912500 49.66616
## 2606 5.900942 49.67043
## 2607 5.895509 49.67193
## 2608 5.890151 49.67340
## 2609 5.878962 49.67784
## 2610 5.872259 49.68431
## 2611 5.871624 49.69093
## 2612 5.874096 49.69931
## 2613 5.881442 49.70488
## 2614 5.886958 49.70840
## 2615 5.887047 49.70846
## 2616 5.891976 49.70977
## 2617 5.899532 49.71239
## 2618 5.902961 49.71292
## 2619 5.904775 49.71291
## 2620 5.908281 49.71231
## 2621 5.911072 49.71106
## 2622 5.916480 49.70671
## 2623 5.920444 49.70440
## 2624 5.923679 49.70326
## 2625 5.929104 49.70219
## 2626 5.933084 49.69933
## 2627 5.938943 49.70310
## 2628 5.942692 49.70532
## 2629 5.945072 49.70645
## 2630 5.946764 49.70700
## 2631 5.949354 49.70771
## 2632 5.951755 49.70873
## 2633 5.954741 49.71043
## 2634 5.962697 49.71545
## 2635 5.964221 49.71626
## 2636 5.965844 49.71694
## 2637 5.967622 49.71741
## 2638 5.972301 49.71796
## 2639 5.974117 49.71826
## 2640 5.978123 49.71947
## 2641 5.978964 49.71967
## 2642 5.980852 49.71995
## 2643 5.982812 49.72005
## 2644 5.985817 49.72002
## 2645 5.988688 49.71985
## 2646 5.992929 49.71941
## 2647 5.995628 49.71451
```

```
## 2648 5.997559 49.71179
## 2649 5.998139 49.71054
## 2650 5.998439 49.70917
## 2651 5.998536 49.70775
## 2652 5.998257 49.70202
## 2653 5.998312 49.69992
##
##
##
## Slot "plotOrder":
## [1] 1
##
## Slot "labpt":
## [1]   5.963503 49.641589
##
## Slot "ID":
## [1] "9"
##
## Slot "area":
## [1] 0.02310772
##
##
## [[10]]
## An object of class "Polygons"
## Slot "Polygons":
## [[1]]
## An object of class "Polygon"
## Slot "labpt":
## [1]   6.023816 49.523310
##
## Slot "area":
## [1] 0.03121033
##
## Slot "hole":
## [1] FALSE
##
## Slot "ringDir":
## [1] 1
##
## Slot "coords":
##              x        y
## 2654 6.039474 49.44826
## 2655 6.036906 49.44870
## 2656 6.036822 49.44871
## 2657 6.031922 49.44954
## 2658 6.027222 49.45034
## 2659 6.026355 49.45215
## 2660 6.025686 49.45354
## 2661 6.019075 49.45409
## 2662 6.007997 49.45501
## 2663 6.002670 49.45544
## 2664 6.001159 49.45557
## 2665 6.001039 49.45558
## 2666 5.983277 49.45136
```

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## 2667 5.982054 49.45107
## 2668 5.980053 49.45325
## 2669 5.979316 49.45405
## 2670 5.985664 49.45955
## 2671 5.980306 49.46277
## 2672 5.975504 49.46565
## 2673 5.974236 49.46642
## 2674 5.973628 49.47001
## 2675 5.972620 49.47595
## 2676 5.972326 49.47769
## 2677 5.972017 49.47952
## 2678 5.971817 49.48069
## 2679 5.970201 49.49022
## 2680 5.955345 49.49333
## 2681 5.945434 49.49964
## 2682 5.938467 49.49988
## 2683 5.936200 49.49995
## 2684 5.926357 49.49879
## 2685 5.911798 49.50163
## 2686 5.906107 49.50018
## 2687 5.899437 49.49846
## 2688 5.893402 49.49692
## 2689 5.864012 49.50125
## 2690 5.855217 49.50713
## 2691 5.836046 49.51996
## 2692 5.835261 49.52652
## 2693 5.841011 49.52855
## 2694 5.844181 49.52967
## 2695 5.840574 49.53512
## 2696 5.836173 49.54178
## 2697 5.827674 49.53964
## 2698 5.817199 49.53700
## 2699 5.814476 49.53965
## 2700 5.810482 49.54354
## 2701 5.814049 49.54458
## 2702 5.815258 49.54494
## 2703 5.815077 49.54517
## 2704 5.815120 49.54519
## 2705 5.815556 49.54544
## 2706 5.826907 49.55189
## 2707 5.827048 49.55219
## 2708 5.828113 49.55283
## 2709 5.833731 49.55125
## 2710 5.843360 49.55635
## 2711 5.850542 49.56017
## 2712 5.857217 49.56553
## 2713 5.867597 49.57154
## 2714 5.868050 49.57181
## 2715 5.868159 49.57189
## 2716 5.872277 49.57021
## 2717 5.877327 49.56771
## 2718 5.878969 49.56715
## 2719 5.879776 49.56701
## 2720 5.883536 49.56698
```

```
## 2721 5.885111 49.56645
## 2722 5.886430 49.56551
## 2723 5.886944 49.56493
## 2724 5.887583 49.56355
## 2725 5.887873 49.56132
## 2726 5.887289 49.54927
## 2727 5.890378 49.54889
## 2728 5.892354 49.54874
## 2729 5.895303 49.54870
## 2730 5.897228 49.54884
## 2731 5.899079 49.54918
## 2732 5.899906 49.54942
## 2733 5.901442 49.55005
## 2734 5.903587 49.55115
## 2735 5.902591 49.55198
## 2736 5.901762 49.55286
## 2737 5.901482 49.55336
## 2738 5.901356 49.55391
## 2739 5.901433 49.55447
## 2740 5.902052 49.55549
## 2741 5.903062 49.55640
## 2742 5.905001 49.55762
## 2743 5.906504 49.55830
## 2744 5.908175 49.55882
## 2745 5.910085 49.55910
## 2746 5.916933 49.55928
## 2747 5.918848 49.55944
## 2748 5.919777 49.55960
## 2749 5.921437 49.56005
## 2750 5.924589 49.56111
## 2751 5.927178 49.56181
## 2752 5.928813 49.56238
## 2753 5.930302 49.56307
## 2754 5.934631 49.56533
## 2755 5.936190 49.56596
## 2756 5.937023 49.56620
## 2757 5.937945 49.56638
## 2758 5.939844 49.56659
## 2759 5.945648 49.56681
## 2760 5.947541 49.56703
## 2761 5.948456 49.56722
## 2762 5.950071 49.56776
## 2763 5.953001 49.56919
## 2764 5.957160 49.57184
## 2765 5.959974 49.57338
## 2766 5.961572 49.57396
## 2767 5.962393 49.57415
## 2768 5.964091 49.57433
## 2769 5.966671 49.57426
## 2770 5.968353 49.57399
## 2771 5.969965 49.57346
## 2772 5.971421 49.57271
## 2773 5.975402 49.57012
## 2774 5.976855 49.56937
```

```
## 2775 5.977658 49.56906
## 2776 5.979294 49.56866
## 2777 5.980999 49.56847
## 2778 5.982724 49.56845
## 2779 5.984435 49.56862
## 2780 5.985270 49.56879
## 2781 5.986956 49.56938
## 2782 5.989211 49.57056
## 2783 6.000514 49.57792
## 2784 6.004476 49.58069
## 2785 6.009423 49.58118
## 2786 6.015318 49.58152
## 2787 6.018118 49.58199
## 2788 6.020684 49.58295
## 2789 6.025437 49.58529
## 2790 6.027193 49.58589
## 2791 6.029217 49.58626
## 2792 6.032394 49.58644
## 2793 6.035647 49.58640
## 2794 6.040028 49.58615
## 2795 6.044250 49.58572
## 2796 6.045683 49.58733
## 2797 6.047641 49.58892
## 2798 6.049973 49.59024
## 2799 6.051765 49.59087
## 2800 6.053652 49.59119
## 2801 6.055595 49.59130
## 2802 6.062551 49.59124
## 2803 6.065510 49.59132
## 2804 6.067427 49.59153
## 2805 6.068703 49.59181
## 2806 6.068896 49.59179
## 2807 6.069071 49.59180
## 2808 6.069232 49.59182
## 2809 6.069523 49.59192
## 2810 6.069814 49.59206
## 2811 6.070204 49.59227
## 2812 6.070968 49.59275
## 2813 6.071922 49.59283
## 2814 6.072338 49.59285
## 2815 6.072425 49.59285
## 2816 6.072949 49.59284
## 2817 6.073338 49.59282
## 2818 6.073703 49.59278
## 2819 6.073843 49.59274
## 2820 6.074032 49.59269
## 2821 6.074171 49.59261
## 2822 6.074270 49.59253
## 2823 6.074332 49.59243
## 2824 6.074385 49.59222
## 2825 6.074383 49.59201
## 2826 6.074314 49.59151
## 2827 6.074285 49.59131
## 2828 6.074260 49.59096
```

```
## 2829 6.074282 49.59072
## 2830 6.074365 49.59050
## 2831 6.074535 49.59028
## 2832 6.074888 49.58998
## 2833 6.076273 49.58907
## 2834 6.076653 49.58878
## 2835 6.076860 49.58857
## 2836 6.076996 49.58835
## 2837 6.077055 49.58812
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## [1] "10"
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## Slot "area":
## [1] 0.03121033
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## [1]   6.167624 49.618151
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## [1] 0.02950228
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## Slot "hole":
## [1] FALSE
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## Slot "ringDir":
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## 3623 6.113731 49.69196
## 3624 6.119020 49.69173
## 3625 6.121083 49.69151
## 3626 6.123077 49.69115
## 3627 6.124029 49.69088
## 3628 6.125786 49.69015
## 3629 6.130529 49.68744
## 3630 6.132005 49.68675
## 3631 6.133796 49.68619
## 3632 6.134824 49.68598
## 3633 6.138038 49.68562
## 3634 6.142470 49.68541
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## [1] "11"
##
## Slot "area":
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## [[1]]
## An object of class "Polygon"
## Slot "labpt":
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##
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## [1] FALSE
##
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##
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## 3988 6.056483 49.83074
## 3989 6.058368 49.83106
## 3990 6.059337 49.83112
## 3991 6.061288 49.83108
## 3992 6.063210 49.83080
## 3993 6.064136 49.83055
## 3994 6.065808 49.82984
## 3995 6.067982 49.82846
##
##
##
## Slot "plotOrder":
## [1] 1
```

```
## 
## Slot "labpt":
## [1]   6.113598 49.757444
## 
## Slot "ID":
## [1] "12"
## 
## Slot "area":
## [1] 0.02911398
## 
## 
## 
## Slot "plotOrder":
##  [1]  1  5  3 10 11 12  2  8  6  9  7  4
## 
## Slot "bbox":
##         min       max
## x  5.74414  6.528252
## y 49.44781 50.181622
## 
## Slot "proj4string":
## Coordinate Reference System:
## Deprecated Proj.4 representation: +proj=longlat +datum=WGS84 +no_defs
## WKT2 2019 representation:
## GEOGCRS["unknown",
##     DATUM["World Geodetic System 1984",
##         ELLIPSOID["WGS 84",6378137,298.257223563,
##             LENGTHUNIT["metre",1]],
##         ID["EPSG",6326]],
##     PRIMEM["Greenwich",0,
##         ANGLEUNIT["degree",0.0174532925199433],
##         ID["EPSG",8901]],
##     CS[ellipsoidal,2],
##         AXIS["longitude",east,
##             ORDER[1],
##             ANGLEUNIT["degree",0.0174532925199433,
##                 ID["EPSG",9122]]],
##         AXIS["latitude",north,
##             ORDER[2],
##             ANGLEUNIT["degree",0.0174532925199433,
##                 ID["EPSG",9122]]]]
```

Extract attribute

```
p$NAME_2
```

```
##  [1] "Clervaux"         "Diekirch"         "Redange"          "Vianden"
##  [5] "Wiltz"            "Echternach"       "Remich"           "Grevenmacher"
##  [9] "Capellen"         "Esch-sur-Alzette" "Luxembourg"       "Mersch"
```

```
p$AREA
```

```
## [1] 312 218 259  76 263 188 129 210 185 251 237 233
```

```
p2 = p[,'NAME_2']
data.frame(p2)
```

```
##             NAME_2
## 1          Clervaux
## 2          Diekirch
## 3           Redange
## 4           Vianden
## 5             Wiltz
## 6        Echternach
## 7            Remich
## 8       Grevenmacher
## 9          Capellen
## 10 Esch-sur-Alzette
## 11       Luxembourg
## 12           Mersch
```

Add new attribute

```
temp = 10 * rexp(12)
p$Temperature = temp
data.frame(p)
```

```
##    ID_1       NAME_1 ID_2           NAME_2 AREA Temperature
## 1     1     Diekirch    1         Clervaux  312    3.858383
## 2     1     Diekirch    2         Diekirch  218    8.265265
## 3     1     Diekirch    3          Redange  259   18.234714
## 4     1     Diekirch    4          Vianden   76   17.891885
## 5     1     Diekirch    5            Wiltz  263    2.747249
## 6     2 Grevenmacher    6       Echternach  188    8.625822
## 7     2 Grevenmacher    7           Remich  129   10.692954
## 8     2 Grevenmacher   12     Grevenmacher  210   18.916094
## 9     3   Luxembourg    8         Capellen  185   29.634423
## 10    3   Luxembourg    9 Esch-sur-Alzette  251   16.349803
## 11    3   Luxembourg   10       Luxembourg  237   13.267974
## 12    3   Luxembourg   11           Mersch  233    8.675113
```

```
i = which(p$NAME_1 == 'Luxembourg')
g = p[i,]
plot(g, axes = T)
```
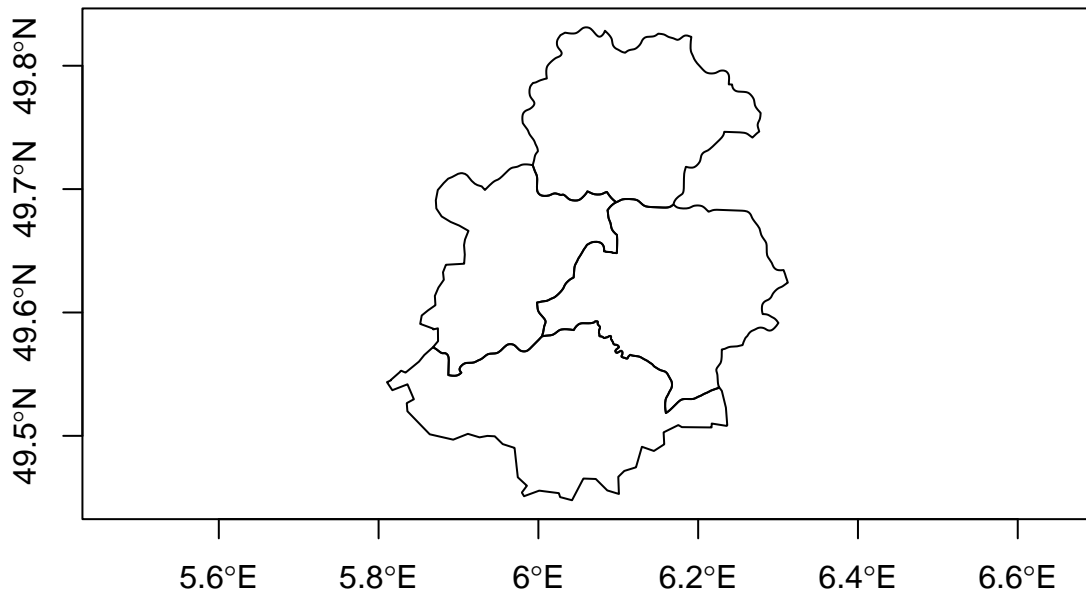
Data integration

```r
dfr = data.frame(District=p$NAME_1, Canton = p$NAME_2,
                 Precip = round(100*rexp(12),3)) # simulation data

dfr[order(dfr$Canton), ]
```

```
##          District              Canton  Precip
## 9     Luxembourg            Capellen  15.955
## 1       Diekirch            Clervaux  11.119
## 2       Diekirch            Diekirch 240.182
## 6  Grevenmacher           Echternach 173.636
## 10    Luxembourg Esch-sur-Alzette  44.158
## 8  Grevenmacher        Grevenmacher  25.021
## 11    Luxembourg          Luxembourg  71.697
## 12    Luxembourg              Mersch  26.798
## 3       Diekirch             Redange  22.577
## 7  Grevenmacher              Remich  67.782
## 4       Diekirch             Vianden 141.077
## 5       Diekirch               Wiltz 175.713
```

```r
data2 = merge(p, dfr, by.x = c('NAME_1', 'NAME_2'), by.y = c('District', 'Canton'))

data.frame(data2)
```

```
##              NAME_1                 NAME_2 ID_1 ID_2 AREA Temperature  Precip
## 1         Diekirch               Clervaux    1    1  312    3.858383  11.119
## 2         Diekirch               Diekirch    1    2  218    8.265265 240.182
## 3         Diekirch                Redange    1    3  259   18.234714  22.577
## 4         Diekirch                Vianden    1    4   76   17.891885 141.077
## 5         Diekirch                  Wiltz    1    5  263    2.747249 175.713
## 6      Grevenmacher             Echternach    2    6  188    8.625822 173.636
## 8      Grevenmacher                 Remich    2    7  129   10.692954  67.782
## 7      Grevenmacher           Grevenmacher    2   12  210   18.916094  25.021
## 9       Luxembourg               Capellen    3    8  185   29.634423  15.955
## 10      Luxembourg Esch-sur-Alzette         3    9  251   16.349803  44.158
## 11      Luxembourg             Luxembourg    3   10  237   13.267974  71.697
## 12      Luxembourg                 Mersch    3   11  233    8.675113  26.798
```

Map manipulation

```r
z = raster(p, nrow=2, ncol=2, vals=1:4)
names(z) = 'Zone'

z = as(z, 'SpatialPolygonsDataFrame')

plot(p, axes=T)
plot(z, add = T, border = 'blue', lwd = 4)
```
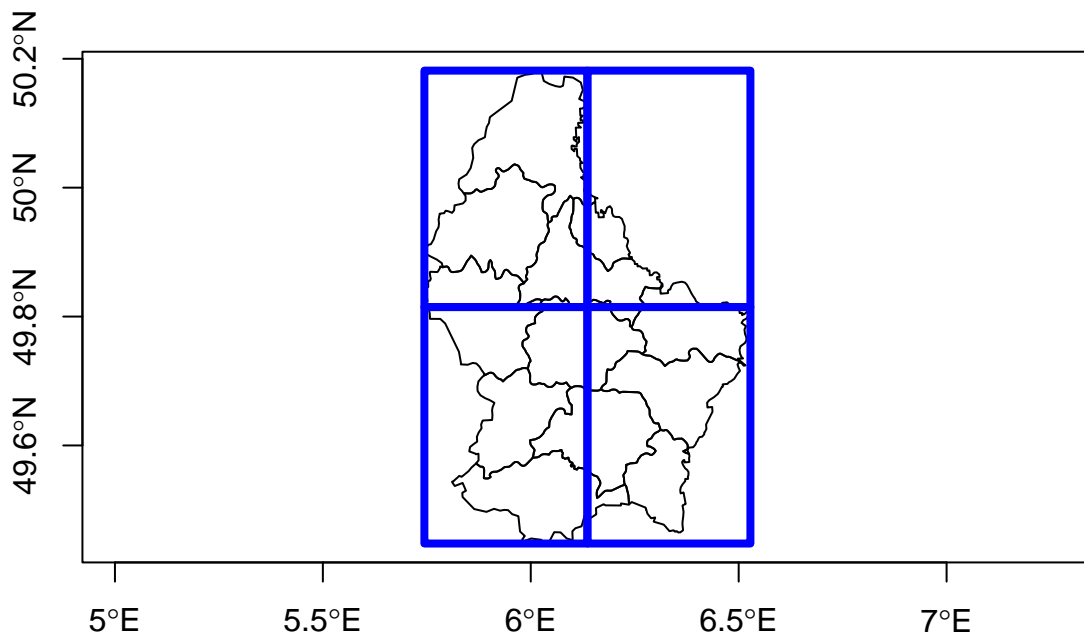

Buang zone tertentu

```r
z2 = z[2, ]
plot(p, axes=T)
plot(z2, add = T, border = 'red')
```
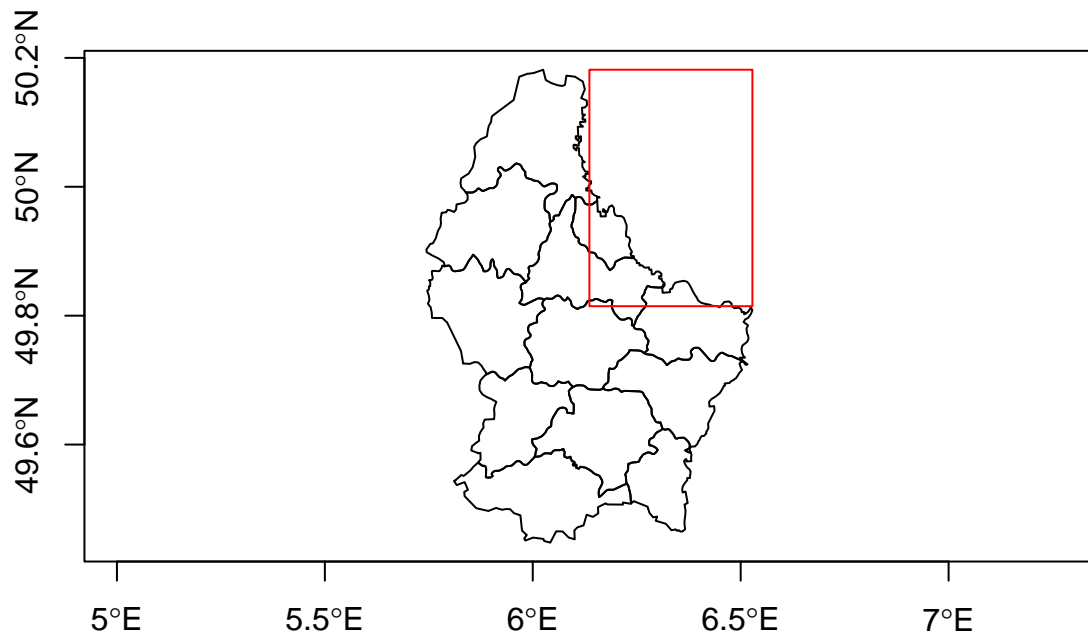


```r
e = erase(p, z2)
plot(e,axes = T)
```
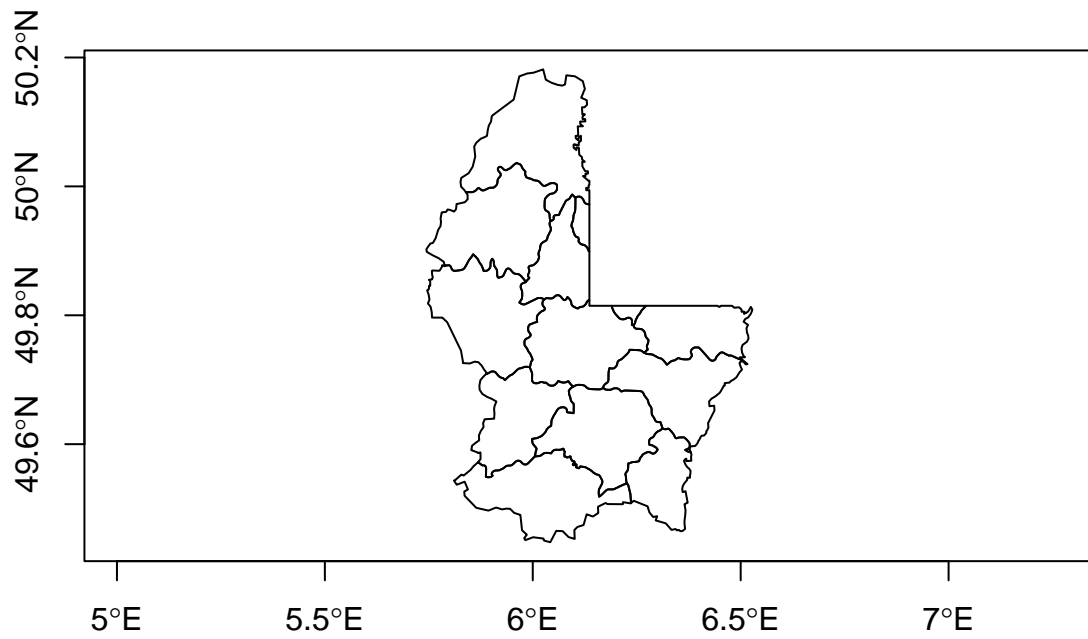
```
e = intersect(p, z2)
plot(e,axes = T)
```
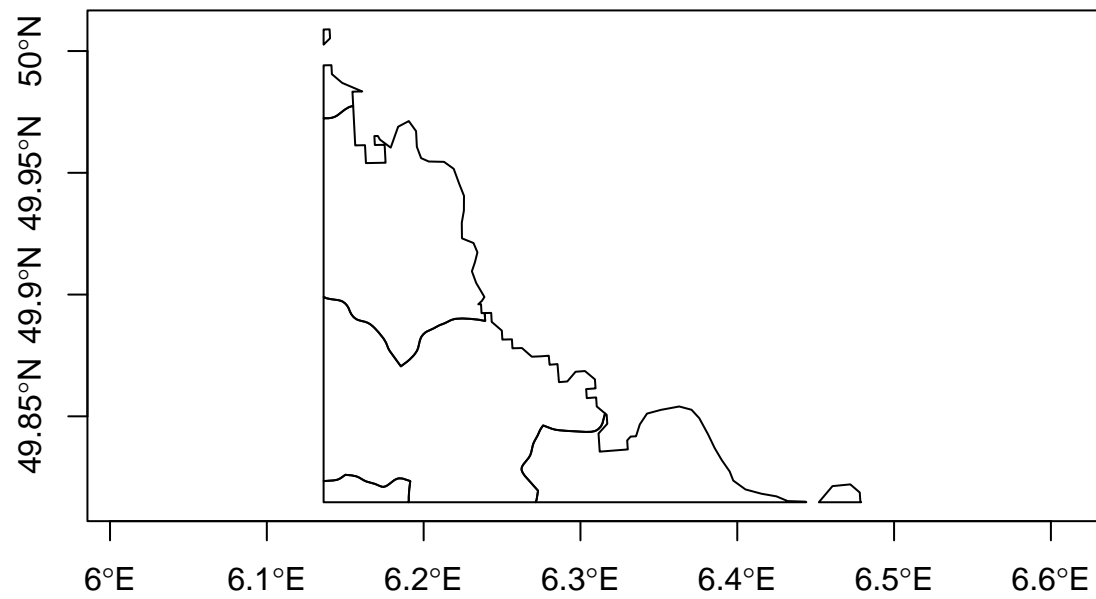
```
e3 = extent(6,6.8,49.7,50)
pe = crop(p, e3)
plot(p, axes=T)
plot(pe, axes = T, col= 'green', add = T)
```
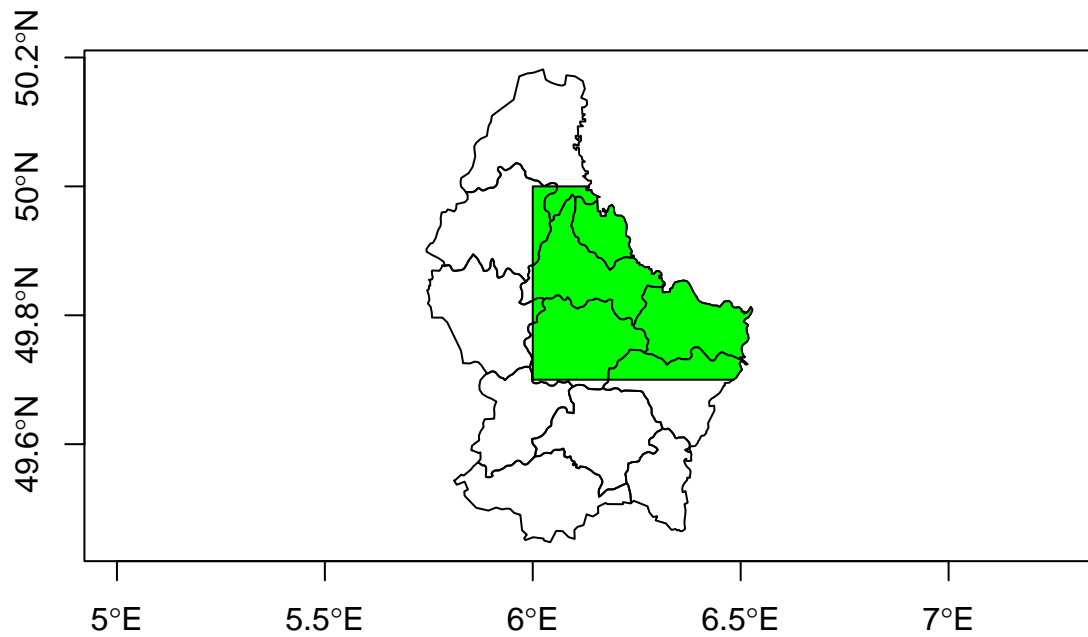
Data manipulation for spatial raster

Extracts a single RasterLayer object from a RasterBrick or RasterStack object.

```
plot(s)
```
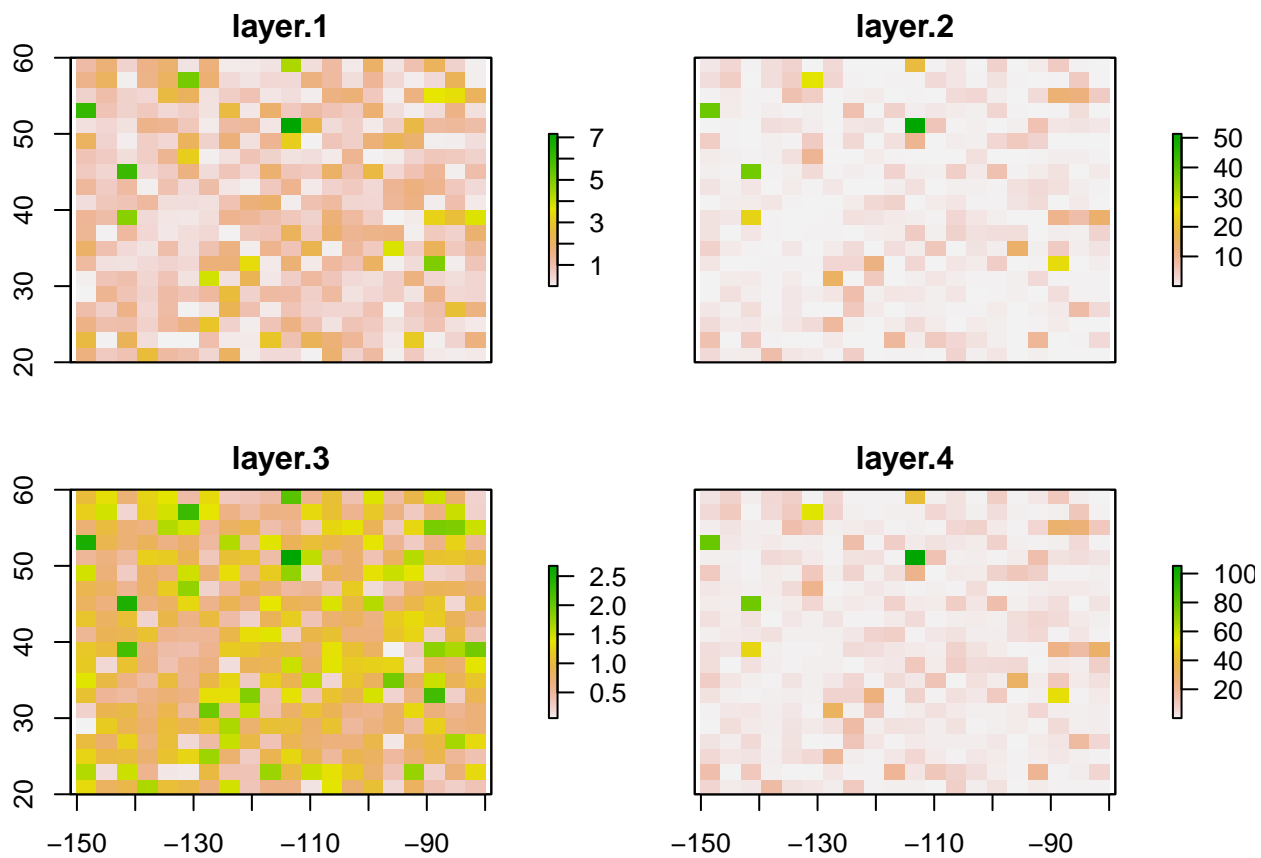
```
r5 = raster(s, layer = 2)
plot(r5)
```
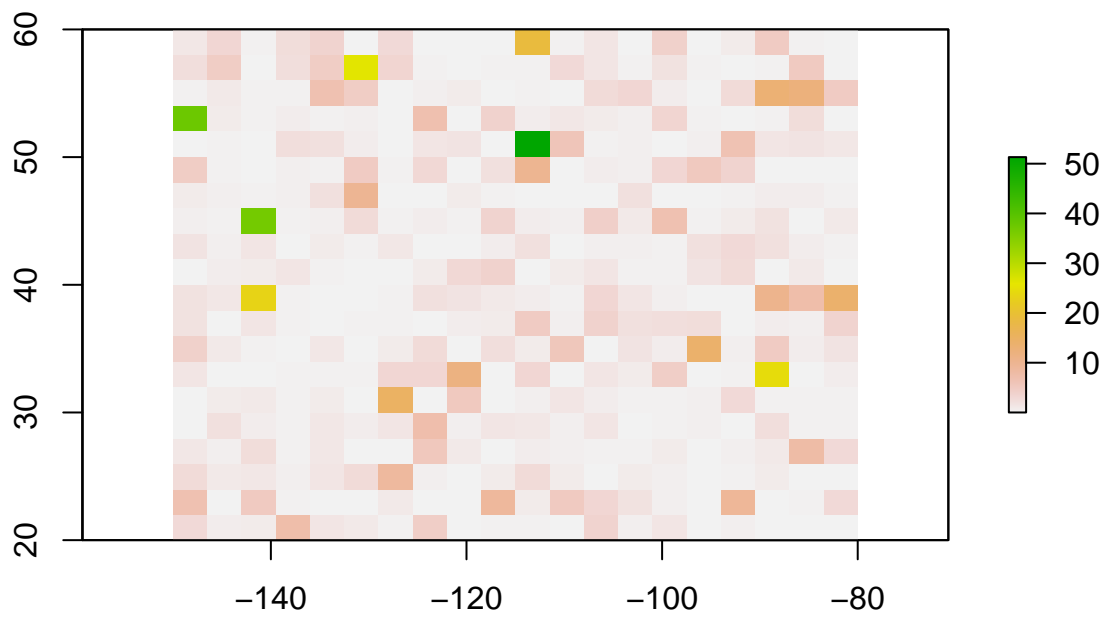
Algebra in raster data

```
r6 = r2 + 10
r7 = r6 ^ 2
r8 = r * r2 + r7
plot(r8)
```
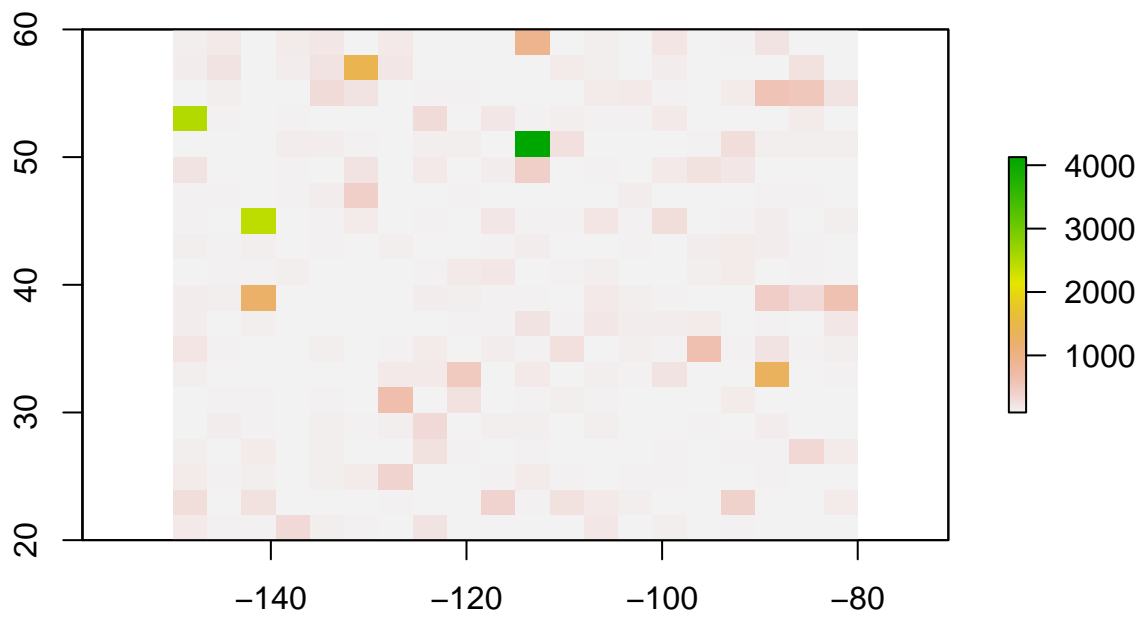
Add new values in the cell.

```r
pi = rgamma(400,30,20)
r8$new = pi
plot(r8)
```
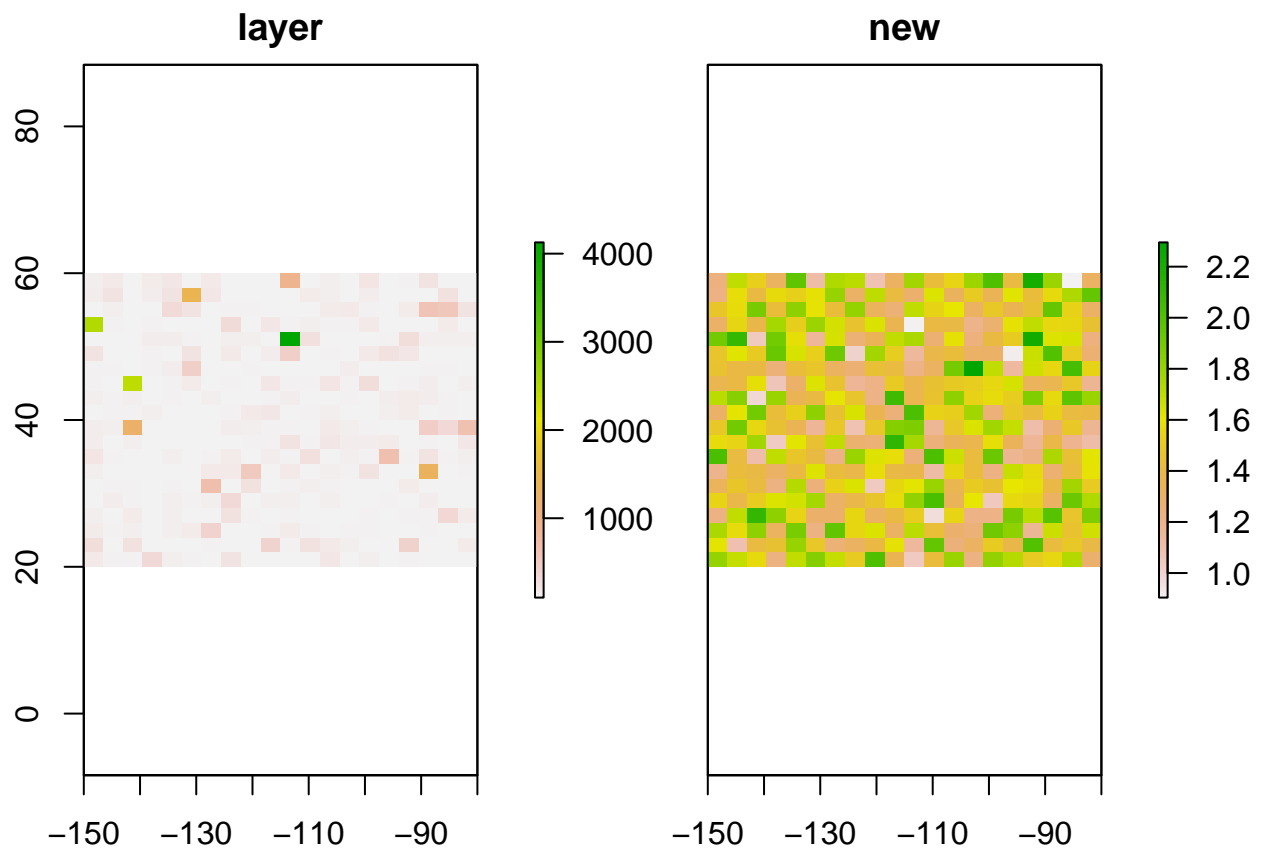
Crop and merge raster data

```
l2 = crop(s, extent(-130, -90, 30,40))
plot(l2)
```
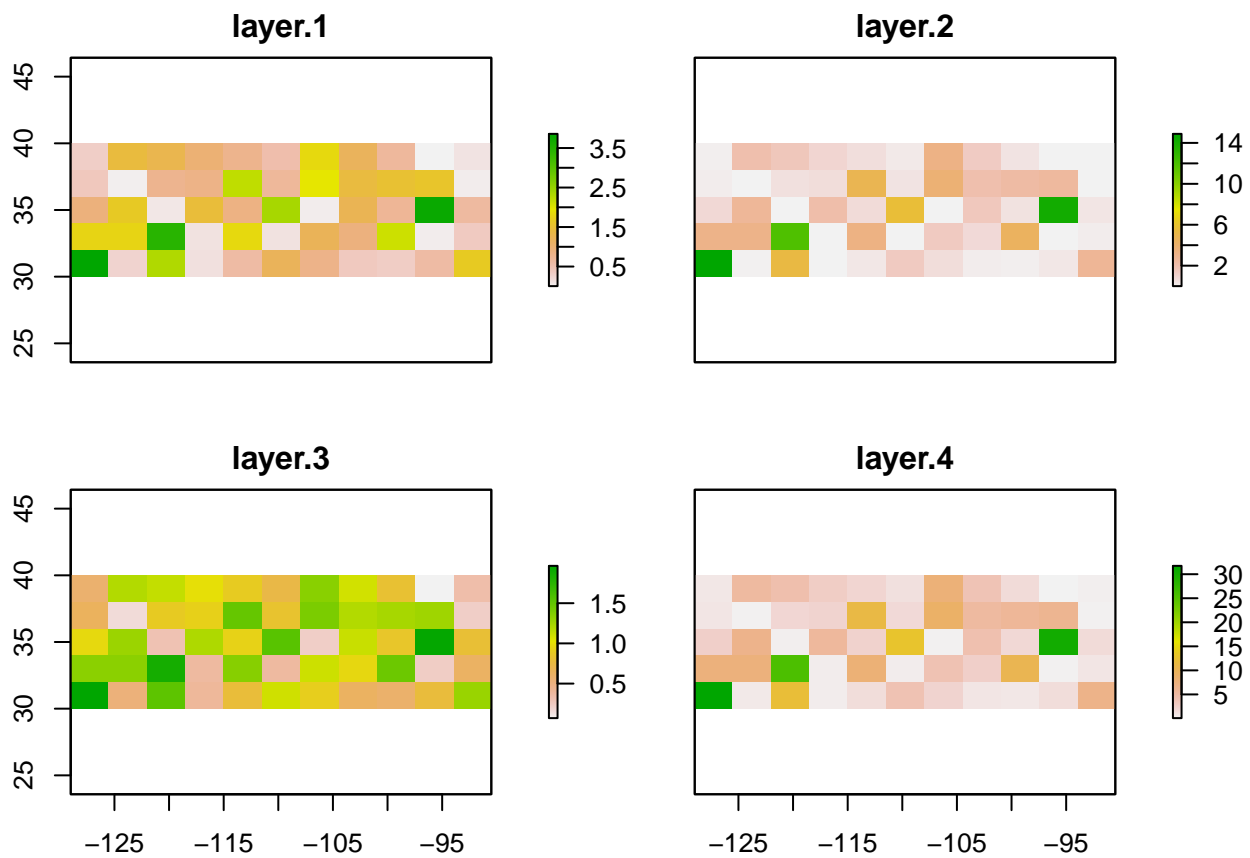
```
l3 = crop(s, extent(-100, -80, 40, 50))
m = merge(l2, l3)
plot(m)
```
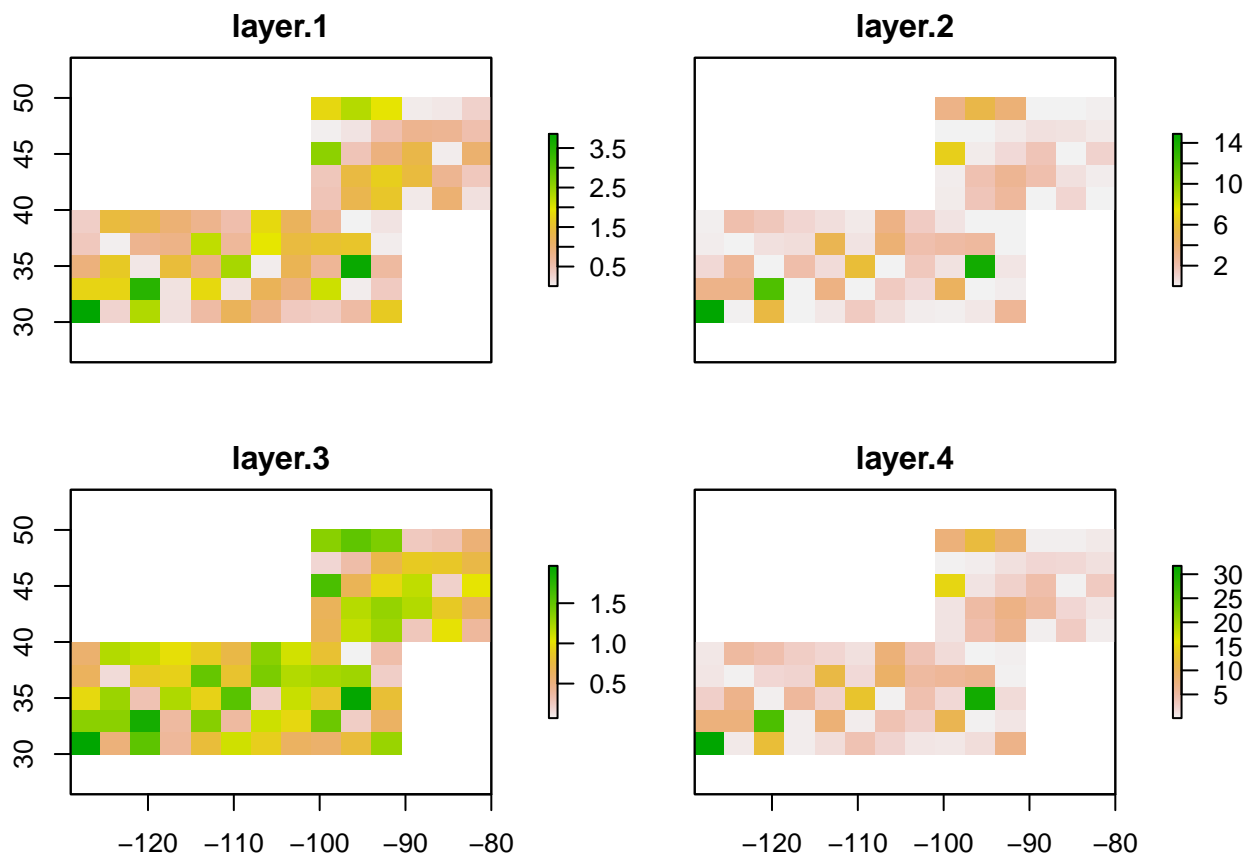
Descriptive functions.

mean

```r
cellStats(s, mean)
```

```
##   layer.1   layer.2   layer.3   layer.4
## 1.0184816 2.0317670 0.9031638 4.9666978
```

standard deviation

```r
cellStats(s, sd)
```

```
##   layer.1   layer.2   layer.3   layer.4
## 0.9984762 4.7800637 0.4508714 9.8976784
```

can try for other statistical measure such as median, range and so on

Spatial Autocorrelation (Moran-i Statistics)

```
p = shapefile(system.file('external/lux.shp', package='raster'))
library(spdep)
```

```
## Warning: package 'spdep' was built under R version 4.4.2
```

```
## Loading required package: spData
```

```
## Warning: package 'spData' was built under R version 4.4.2
```

```
## To access larger datasets in this package, install the spDataLarge
## package with: 'install.packages('spDataLarge',
## repos='https://nowosad.github.io/drat/', type='source')'
```

```
## Loading required package: sf
```

```
## Warning: package 'sf' was built under R version 4.4.2
```

```
## Linking to GEOS 3.13.0, GDAL 3.10.1, PROJ 9.5.1; sf_use_s2() is TRUE
```

```
w = poly2nb(p)
ww = nb2listw(w)
moran.test(p$AREA, ww)
```

```
##
##   Moran I test under randomisation
##
## data:  p$AREA
## weights: ww
##
## Moran I statistic standard deviate = -0.93397, p-value = 0.8248
## alternative hypothesis: greater
## sample estimates:
## Moran I statistic       Expectation          Variance
##       -0.24476153       -0.09090909        0.02713563
```

Interpretation :

- p-value 0.8248

Spatial interpolation

```
library(devtools)
```

```
## Warning: package 'devtools' was built under R version 4.4.2
```

```
## Loading required package: usethis
```

```
## Warning: package 'usethis' was built under R version 4.4.2
```

```r
#install_github('rspatial/rspat')
library(rspat)


#precipitation in California
d = spat_data('precipitation')


d$prec = rowSums(d[, 6:17])
dsp = vect(d, c('LONG', 'LAT'), crs = '+proj=longlat +datum=WSG84')


## Warning: PROJ: proj_create: Error 1027 (Invalid value for an argument): Unknown
## value for datum (GDAL error 1)

## Warning: [vect] Cannot set SRS to vector: empty srs

CA = spat_data('counties')


cuts = c(0, 200, 300, 500, 1000, 3000)
library(ggplot2)
blues = colorRampPalette(c('yellow', 'orange', 'purple', 'blue',
                           'darkblue'))
plot(CA)
plot(dsp, 'prec', type = 'interval', col=blues(10), breaks=cuts, add=T)
```
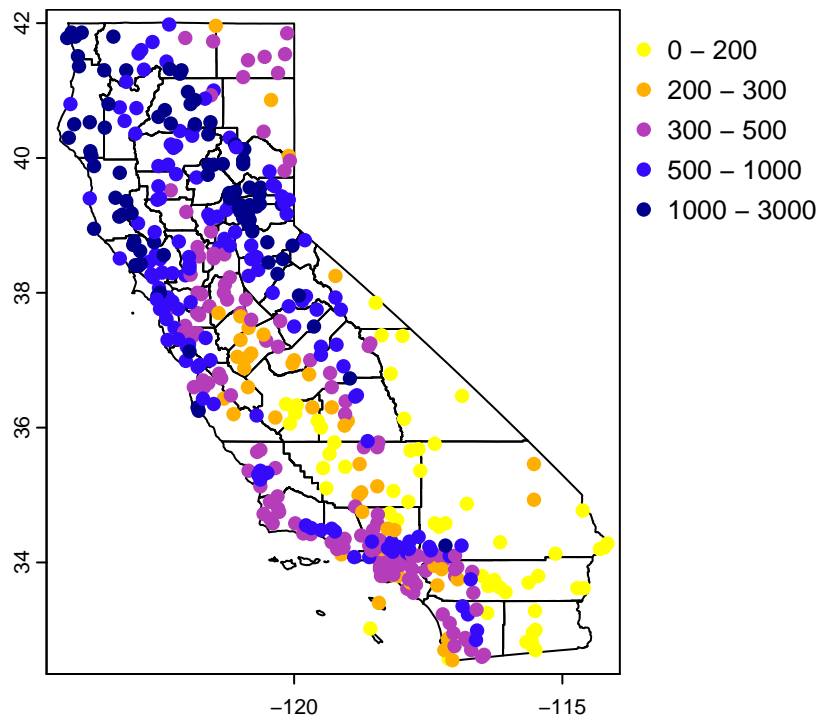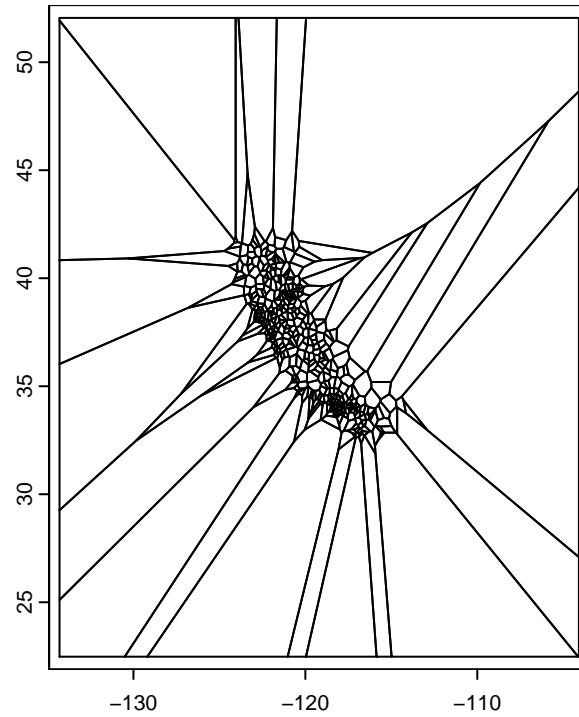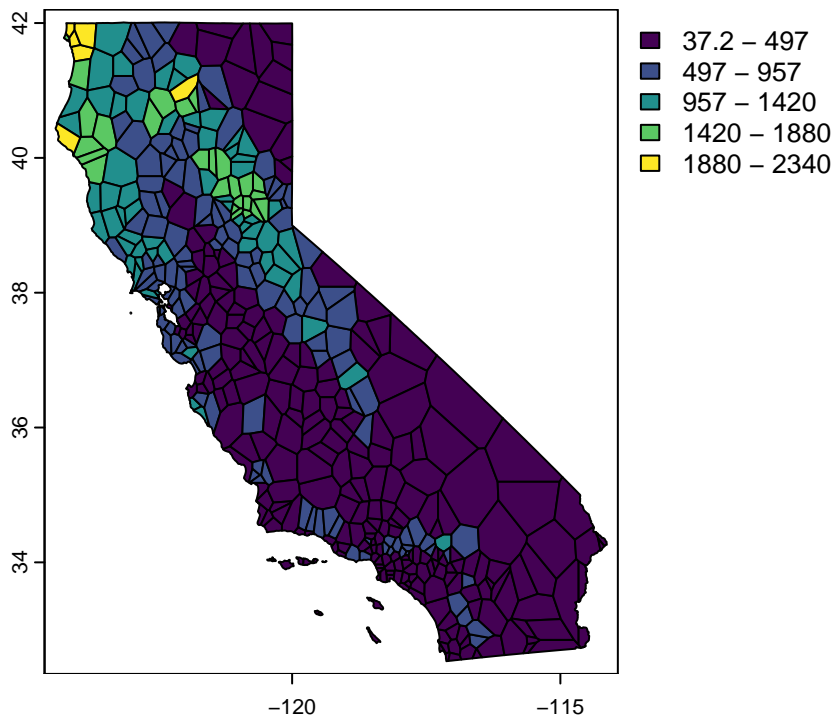
```
v = voronoi(dsp)
plot(v)
```



```
vca = crop(v, CA)
plot(vca, 'prec')
```

```r
houses = read.csv('./Data/hd.csv')
str(houses)
```

```
## 'data.frame':    41280 obs. of   19 variables:
##  $ houseValue : int  452600 358500 352100 341300 342200 269700 299200 241400 226700 261100 ...
##  $ income     : num  8.33 8.3 7.26 5.64 3.85 ...
##  $ houseAge   : int  41 21 52 52 52 52 52 52 42 52 ...
##  $ rooms      : int  880 7099 1467 1274 1627 919 2535 3104 2555 3549 ...
##  $ bedrooms   : int  129 1106 190 235 280 213 489 687 665 707 ...
##  $ population : int  322 2401 496 558 565 413 1094 1157 1206 1551 ...
##  $ households : int  126 1138 177 219 259 193 514 647 595 714 ...
##  $ latitude   : num  37.9 37.9 37.9 37.9 37.9 ...
##  $ longitude  : num  -122 -122 -122 -122 -122 ...
##  $ id.y       : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ STATE      : int  6 6 6 6 6 6 6 6 6 6 ...
##  $ COUNTY     : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ NAME       : chr  "Alameda" "Alameda" "Alameda" "Alameda" ...
##  $ LSAD       : int  6 6 6 6 6 6 6 6 6 6 ...
##  $ LSAD_TRANS : chr  "County" "County" "County" "County" ...
##  $ suminc     : num  1049 9447 1285 1236 996 ...
##  $ roomhead   : num  2.73 2.96 2.96 2.28 2.88 ...
##  $ bedroomhead: num  0.401 0.461 0.383 0.421 0.496 ...
##  $ hhsize     : num  2.56 2.11 2.8 2.55 2.18 ...
```

Transform data into spatial

```
hvect = vect(houses, c('longitude', 'latitude'))
plot(hvect, cex=0.5, axes=T)
```
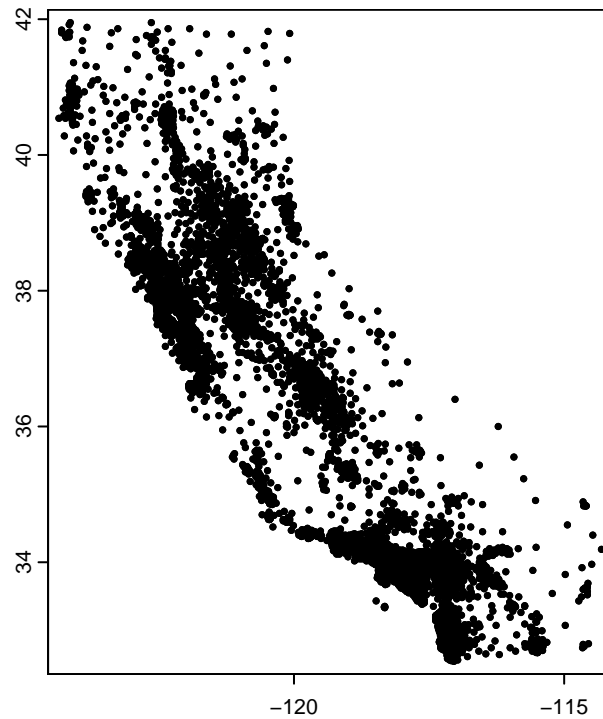


```
countries = spat_data('counties')
crs(hvect) = crs(countries)

# normal regression
hd = houses
model = glm(houseValue~income+houseAge+roomhead+bedroomhead+population,
            data = hd)
summary(model)
```
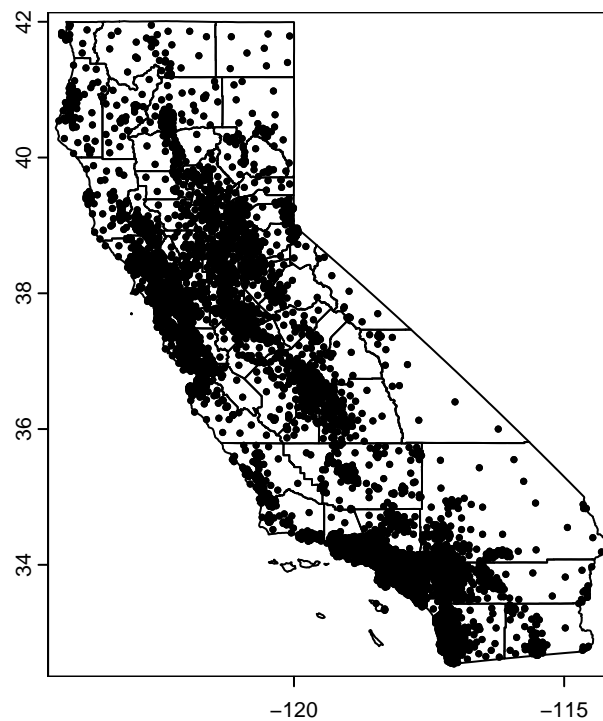
```
##
## Call:
## glm(formula = houseValue ~ income + houseAge + roomhead + bedroomhead +
##     population, data = hd)
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -6.508e+04  1.791e+03  -36.33   <2e-16 ***
## income       5.179e+04  2.710e+02  191.06   <2e-16 ***
## houseAge     1.832e+03  3.235e+01   56.63   <2e-16 ***
## roomhead    -4.720e+04  1.053e+03  -44.82   <2e-16 ***
## bedroomhead  2.648e+05  4.822e+03   54.91   <2e-16 ***
## population   3.947e+00  3.593e-01   10.99   <2e-16 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for gaussian family taken to be 6021551957)
##
##     Null deviance: 5.4966e+14  on 41279  degrees of freedom
## Residual deviance: 2.4853e+14  on 41274  degrees of freedom
## AIC: 1046724
##
## Number of Fisher Scoring iterations: 2
```

```r
# geographically weighted regression (GWR)
plot(hvect, cex = 0.5, axes = T)
plot(countries, add = T)
```
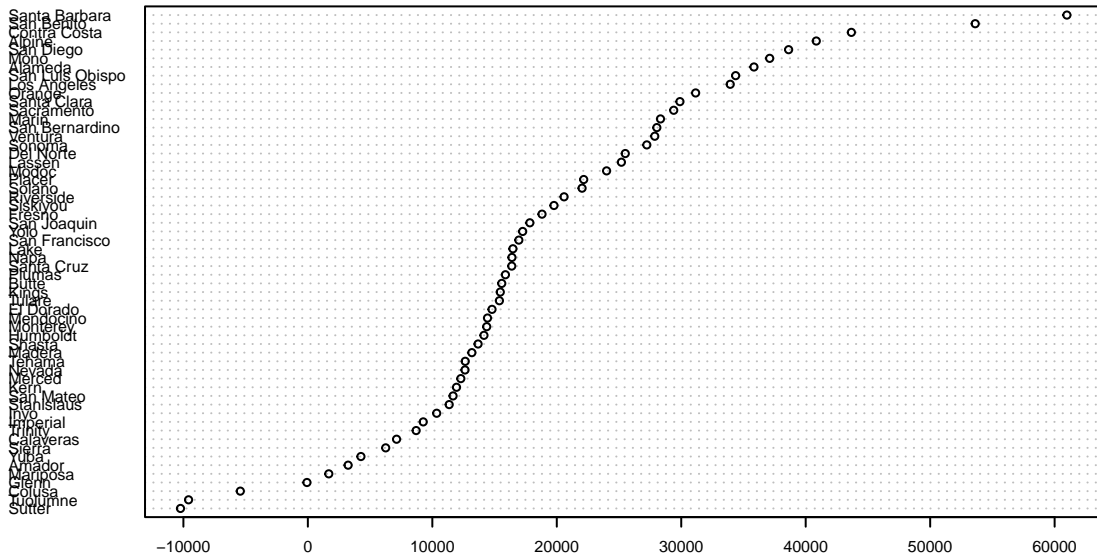


```r
countrynames = unique(hd$NAME)

# Regression model towards difference places
regfun = function (x) {
  dat = hd[hd$NAME == x, ]
  m = glm(houseValue~income+houseAge+roomhead+bedroomhead+population,
        data = dat)
  coefficients(m)
}
```

```
hd2 = hd[!is.na(hd$NAME ), ]
countrynames = unique(hd2$NAME)
res = sapply(countrynames, regfun)

# effect of income toward house value
dotchart(sort(res['income', ]), cex = 0.5)
```



```
# create map for variance parameter local regression
resdf = data.frame(NAME=colnames(res), t(res))
dcounties = aggregate(countries[, 'NAME'], 'NAME')
cnres = merge(dcounties, resdf, by = 'NAME')

# influence of income toward house value according to different locations
plot(cnres, 'income')
```

117
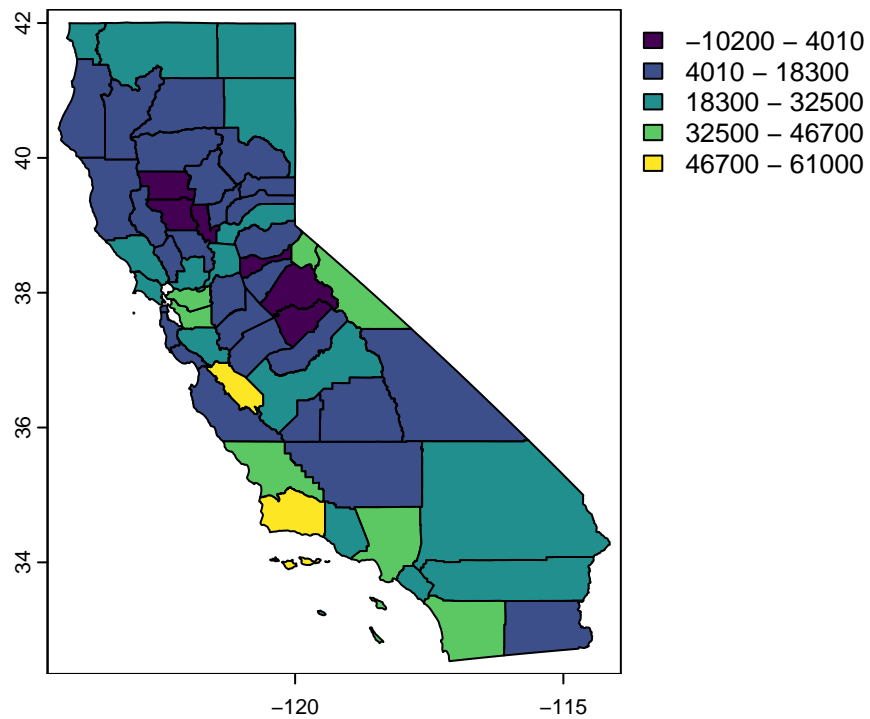
```r
# for other variables
cnres2 = cnres
values(cnres2) = as.data.frame(scale(as.data.frame(cnres)[-1]))
plot(cnres2, 2:7, plt=list(x='topright'), mar=c(1,1,1,1))
```