Using GADMTools

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Epiconcept is made up of a team of doctors, epidemiologists, data scientists and digital specialists. For more than 20 years, Epiconcept has been contributing to the improvement of public health programs by providing software, epidemiological studies, counseling, evaluation and training to better prevent, detect and treat people.

Epiconcept delivers software and services in the following areas :

- Software for managing public health programs,
- Secure cloud solutions for health data collection, reporting and processing,
- The implementation of research projects on measuring the effectiveness and impact of vaccines,
- Services in the field of epidemiology (protocols, analyzes, training, etc.),
- Expertise in data analysis,
- Counseling, coaching and assistance to project owners for public health programs,
- Training (short introductory modules, training through long-term practice).

To achieve such goals Epiconcept :

- Recognized research organization,
- Certified datacenter for hosting personal health data,
- Training organisation.

Epiconcept relies on :

- Its expertise in epidemiology
- Its IT expertise,
- Ethical values rooted in practice (responsibility and quality of services, data security and confidentiality, scientific independence, etc.),
- Capabilities to answer and anticipate tomorrow's challenges (Research - evaluation, e-health, Big Data, IoT, etc.),
- A desire to build long-term relationships with its clients and partners.

Its current customers and partners include some of the greatest names in the world such as : Santé Publique France (and many public health organizations around the world), WHO, eCDC, AFD, MSF, World Bank, etc.

What is GADM?

GADM, the Database of Global Administrative Areas, is a high-resolution database of country administrative areas, with a goal of "all countries, at all levels, at any time period. The database has a few export formats, including shapefiles that are used in most common GIS applications.[2] Files formatted for the programming language R are also available, allowing the easy creation of descriptive data plots that include geographical maps. Although it is a public database, GADM has a higher spatial resolution than other free databases and also higher than commercial software such as ArcGIS. GADM is not freely available for commercial use. The GADM project created the spatial data for many countries from spatial databases provided by national governments, NGO, and/or from maps and lists of names available on the Internet (e.g. from Wikipedia).

The GADM website and data repository is hosted at UC Davis in the Hijmans Lab. The Hijman lab is run by Robert Hijmans an Environmental Science and Policy faculty member in the Geography Graduate Group. [source Wikipedia - https://en.wikipedia.org/wiki/GADM]

What is GADMTools?

GADMTools is an R package to manipulate shapefiles from GADM and to make geo-statistical representations easily.

Manipulating shapefiles

gadm.loadCountries()

This is the main function of GADMTools, with it, you can load or download one or more shapefiles. If you load many shapefiles, the function assembles the shapefiles into one.

gadm.loadCountries(

```
fileNames,

level = 0,

basefile=GADM_BASE,

baseurl=GADM_URL,

simplify=NULL

)
```

Parameter	Description
fileNames	**Character vector** of named regions. An ISO-3166-1 code or a custom name. You don't have to specify the suffix (admX) nor the file extension (.rds).
level	**Integer** - the level of the administrative boundaries (0 is the country, higher values equal finer divisions)
basefile	**Character** - the path of the directory where shapefiles are stored. Default is "./GADM"
baseurl	**Character** - the url of GADM files. Default is http://biogeo.ucdavis.edu/data/gadm2.8/rds/
simplify	**Numeric** numerical tolerance value to be used by the Douglas-Peuker algorithm. Higher values use less polygon points (and less memory) and lower values use more polygon points (and more memory). We suggest not going higher than 0.01 in order for intra-country boundaries to align.

ISO3 CODES

ABW	AFG	AGO	AIA	ALA	ALB	AND	ANT	ARE	ARG
ARM	ASM	ATA	ATF	ATG	AUS	AUT	AZE	BDI	BEL
BEN	BFA	BGD	BGR	BHR	BHS	BIH	BLM	BLR	BLZ
BMU	BOL	BRA	BRB	BRN	BTN	BVT	BWA	CAF	CAN
CCK	CHE	CHL	CHN	CIV	CMR	COD	COG	COK	COL
COM	CPV	CRI	CUB	CXR	CYM	CYP	CZE	DEU	DJI
DMA	DNK	DOM	DZA	ECU	EGY	ERI	ESH	ESP	EST
ETH	FIN	FJI	FLK	FRA	FRO	FSM	GAB	GBR	GEO
GGY	GHA	GIB	GIN	GLP	GMB	GNB	GNQ	GRC	GRD
GRL	GTM	GUF	GUM	GUY	HKG	HMD	HND	HRV	HTI
HUN	IDN	IMN	IND	IOT	IRL	IRN	IRQ	ISL	ISR
ITA	JAM	JEY	JOR	JPN	KAZ	KEN	KGZ	KHM	KIR
KNA	KOR	KWT	LAO	LBN	LBR	LBY	LCA	LIE	LKA
LSO	LTU	LUX	LVA	MAC	MAF	MAR	MCO	MDA	MDG
MDV	MEX	MHL	MKD	MLI	MLT	MMR	MNE	MNG	MNP
MOZ	MRT	MSR	MTQ	MUS	MWI	MYS	MYT	NAM	NCL
NER	NFK	NGA	NIC	NIU	NLD	NOR	NPL	NRU	NZL
OMN	PAK	PAN	PCN	PER	PHL	PLW	PNG	POL	PRI
PRK	PRT	PRY	PSE	PYF	QAT	REU	ROU	RUS	RWA
SAU	SDN	SEN	SGP	SGS	SHN	SJM	SLB	SLE	SLV
SMR	SOM	SPM	SRB	STP	SUR	SVK	SVN	SWE	SWZ
SYC	SYR	TCA	TCD	TGO	THA	TJK	TKL	TKM	TLS
TON	TTO	TUN	TUR	TUV	TWN	TZA	UGA	UKR	UMI
URY	USA	UZB	VAT	VCT	VEN	VGB	VIR	VNM	VUT
WLF	WSM	YEM	ZAF	ZMB	ZWE				

Loading a shapefile

```
library(GADMTools)
library(sp)

# Loading country border (level=0 [default])
# ------------------------------------------------------------------
map <- gadm.loadCountries("FRA", basefile = "./")
plotmap(map)
```

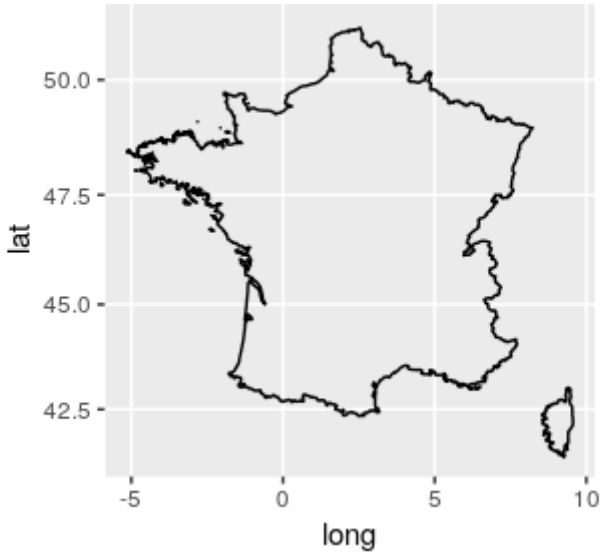

Figure 1: loading a single country (France) @ level = 0

Loading an administrative level

```
library(GADMTools)
library(sp)

# Loading regions @ level = 2])
# ------------------------------------------------------------------
map <- gadm.loadCountries(c("FRA"), level=2, basefile = "./")
plotmap(map)
```

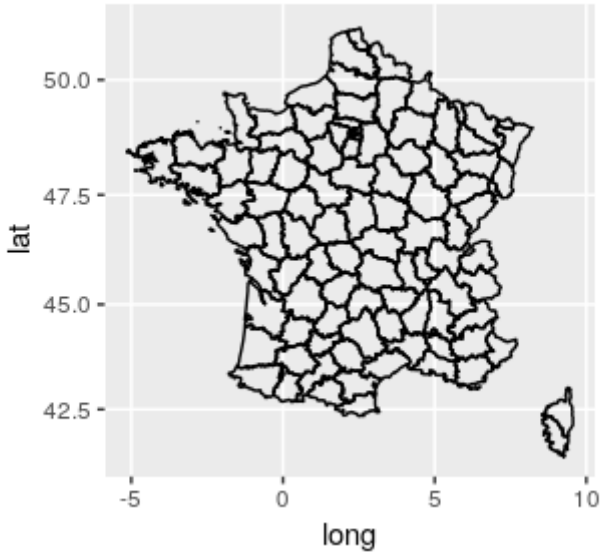

Figure 2: loading regions of a country (France) @ level = 2

Assembling many shapefiles

```
library(GADMTools)
library(sp)

# Assemble administrative boundaries (country level = 0)
# ------------------------------------------------------------------
map <- gadm.loadCountries(c("BEL","LUX","NLD"))
plotmap(map, title="Bénélux")
```

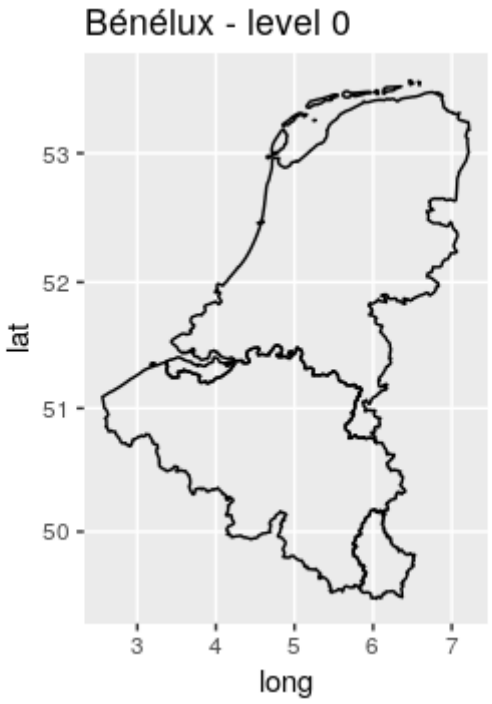

Figure 3: Benelux = Belgium + Luxembourg + Netherlands @ level = 0

Extracting regions

In order to extract some regions of a map we need to know them. The listNames function allows this. The subset function is then used to extract the desired regions.

listNames()

listNames(

```
    x,

    level = 0

   )
```

Parameter	Description
x	**Object** - a GADMWrapper object (a map)
level	**Integer** - the value of the administration level to list. Attention: only the administrative levels that have been loaded in the loadCountries object can be listed. Names are given in the country's language or English.

subset()

subset(

```
  x,

  level = NULL,

  regions = NULL

 )
```

Parameter	Description
x	**Object** GADMWrapper
level	**Integer** the level at which the regions are extracted from
regions	**String vector** of named regions

Example

```
# Extract some regions of a map
# ------------------------------------------------------------------
library(GADMTools)
library(sp)

FR = gadm.loadCountries("FRA", level=2)
listNames(FR, level=2)
AV = subset(FR, regions=c("Allier", "Cantal",
            "Haute-Loire","Puy-de-Dôme"))
plotmap(AV)
```

[1] "Bas-Rhin"	"Haut-Rhin"	"Dordogne"	"Gironde"
[5] "Landes"	"Lot-et-Garonne"	"Pyrénées-Atlantiques"	"Allier"
[9] "Cantal"	"Haute-Loire"	"Puy-de-Dôme"	"Essonne"
[13] "Hauts-de-Seine"	"Paris"	"Seine-et-Marne"	"Seine-Saint-Denis"
[17] "Val-d'Oise"	"Val-de-Marne"	"Yvelines"	"Calvados"
[21] "Manche"	"Orne"	"Côte-d'Or"	"Nièvre"
[25] "Saône-et-Loire"	"Yonne"	"Côtes-d'Armor"	"Finistère"
[29] "Ille-et-Vilaine"	"Morbihan"	"Cher"	"Eure-et-Loir"
[33] "Indre-et-Loire"	"Indre"	"Loir-et-Cher"	"Loiret"
[37] "Ardennes"	"Aube"	"Haute-Marne"	"Marne"
[41] "Corse-du-Sud"	"Haute-Corse"	"Doubs"	"Haute-Saône"
[45] "Jura"	"Territoire de Belfort"	"Eure"	"Seine-Maritime"
[49] "Aude"	"Gard"	"Hérault"	"Lozère"
[53] "Pyrénées-Orientales"	"Corrèze"	"Creuse"	"Haute-Vienne"
[57] "Meurthe-et-Moselle"	"Meuse"	"Moselle"	"Vosges"
[61] "Ariège"	"Aveyron"	"Gers"	"Haute-Garonne"
[65] "Hautes-Pyrénées"	"Lot"	"Tarn-et-Garonne"	"Tarn"
[69] "Nord"	"Pas-de-Calais"	"Loire-Atlantique"	"Maine-et-Loire"
[73] "Mayenne"	"Sarthe"	"Vendée"	"Aisne"
[77] "Oise"	"Somme"	"Charente-Maritime"	"Charente"
[81] "Deux-Sèvres"	"Vienne"	"Alpes-de-Haute-Provence"	"Alpes-Maritimes"
[85] "Bouches-du-Rhône"	"Hautes-Alpes"	"Var"	"Vaucluse"
[89] "Ain"	"Ardèche"	"Drôme"	"Haute-Savoie"
[93] "Isère"	"Loire"	"Rhône"	"Savoie"

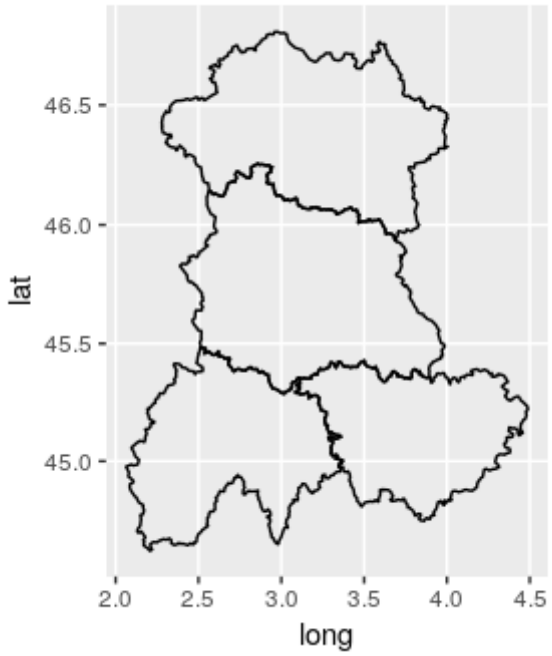

Figure 4: extracting (subset) some departments in France @ level = 2

Removing regions

remove()

remove(

```
  x,

  level=NULL,

  regions=NULL

)
```

Parameter	Description
x	**Object** GADMWrapper
level	**Integer** - level from which shapes are removed. If NULL, curent level is used.
regions	**String vector** of regions to be removed

Example

```
library(GADMTools)
library(sp)

FR = gadm.loadCountries("FRA", level=1)
plotmap(FR)
listNames(FR, level=1)
FR2 = remove(FR, level = 1, regions = c("Alsace", "Lorraine"))
plotmap(FR2)
```

[1] “Alsace”	“Aquitaine”	“Auvergne”
[4] “Île-de-France”	“Basse-Normandie”	“Bourgogne”
[7] “Bretagne”	“Centre”	“Champagne-Ardenne”
[10] “Corse”	“Franche-Comté”	“Haute-Normandie”
[13] “Languedoc-Roussillon”	“Limousin”	“Lorraine”
[16] “Midi-Pyrénées”	“Nord-Pas-de-Calais”	“Pays de la Loire”
[19] “Picardie”	“Poitou-Charentes”	“Provence-Alpes-Côte d’Azur”
[22] “Rhône-Alpes”		

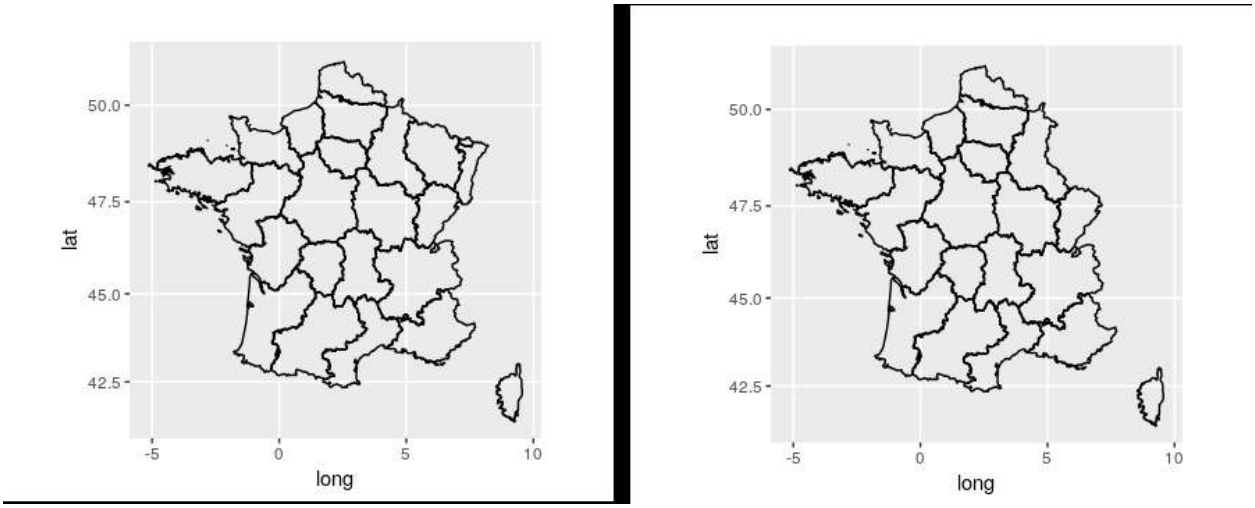

Figure 5: removing 2 regions from France @ level = 1

Graphics

Plotting dots on a map

dots()

dots(

```
   x, points, color="red", value = NULL,

   breaks = NULL, steps = 5, palette = NULL, labels = NULL, strate = NULL,

   title="", legend = NULL, note=NULL
```

)

Parameter	Description
x	**Object** GADMWrapper
points	**Object** data.frame with columns 'latitude' and 'longitude'
color	a valid color
value	**Character** Name of a column in the data.frame. If is not null, colored dots are displayed according to the value.
breaks	**vector** of breaks
steps	**Integer** Number of breaks for the value field.
palette	a valid palette
labels	**vector** of labels
strate	**Character** name of a column in the data.frame. If is not null, display dots with different shapes according to the value.
title	**Character** The title of the plot
legend	**Character** The title of the legend
note	**Character** Add an annotation

Examples

For these examples we are using this data.frame

lieu_lat	lieu_long	type	comptage	nocif	id_data	identifier
49.55895	1.384277	Type B	45	ne sait pas	1	1
48.86664	2.636719	Type A	21	Oui	2	2
48.60579	1.933594	Type B	12	Non	3	3
48.90998	2.482910	Type B	61	ne sait pas	4	4
48.97493	2.208252	Type C	14	Oui	5	5
49.06859	3.054199	Type B	14	Oui	6	6
48.82326	1.614990	Type A	55	Non	7	7
48.87387	2.307129	Type D	7	ne sait pas	9	9
48.99656	2.156067	Type B	19	Oui	10	10
49.03259	2.834473	Type D	12	Non	11	11
49.10792	2.351074	Type C	6	Oui	12	12
48.56219	2.438965	Type B	65	Oui	13	13
48.71465	2.169800	Type A	22	Non	14	14

Note : with this data.frame, we have to rename *lieu_lat* and *lieu_long* to respectively *latitude* and *longitude*

```
library(GADMTools)
library(sp)

map = gadm.loadCountries("FRA", level=1, simplify=0.01)
map = subset(map, level=1, regions=c("Île-de-France","Haute-Normandie"))

W <- read.csv2("wepi.csv", stringsAsFactors = FALSE)
W$lieux_lat <- as.double(W$lieux_lat)
W$lieux_long <- as.double(W$lieux_long)
colnames(W)[1] <- "latitude"
colnames(W)[2] <- "longitude"

# Simple dots
#-----------------------------------------------------------------------
dots(map, points = W, title="Cases 2015", note="Data from Wepi")
```

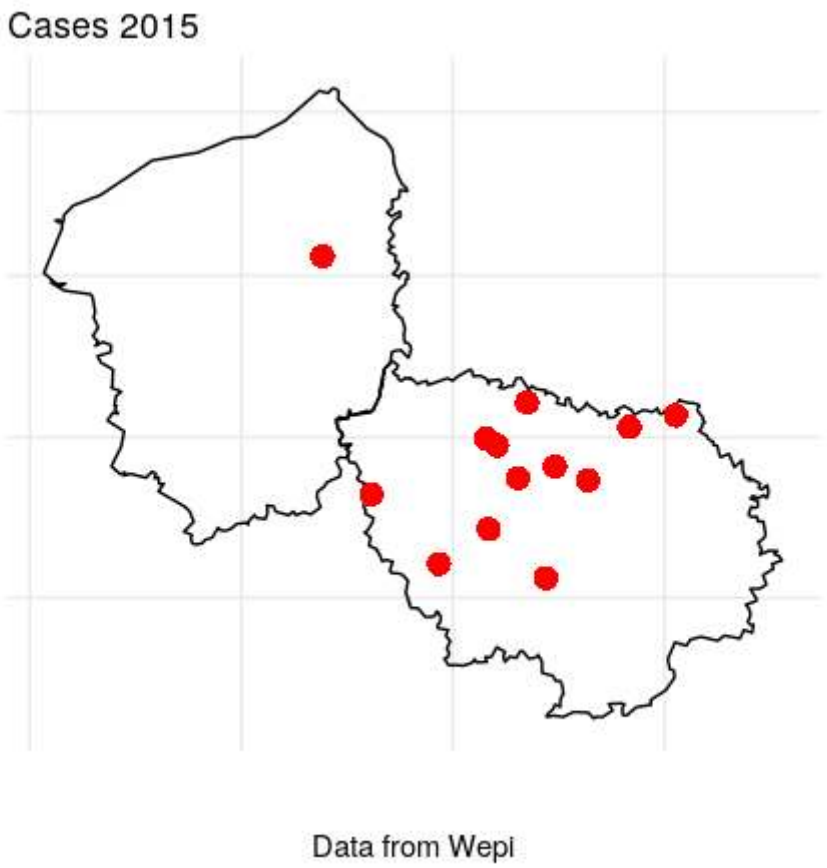

Figure 6: simple points

```
# Classified dots
#-------------------------------------------------------------------
dots(map, points = W,
     palette = "Reds",
     value="comptage",
     title="Classified Cases 2015", note="Data from Wepi")
```

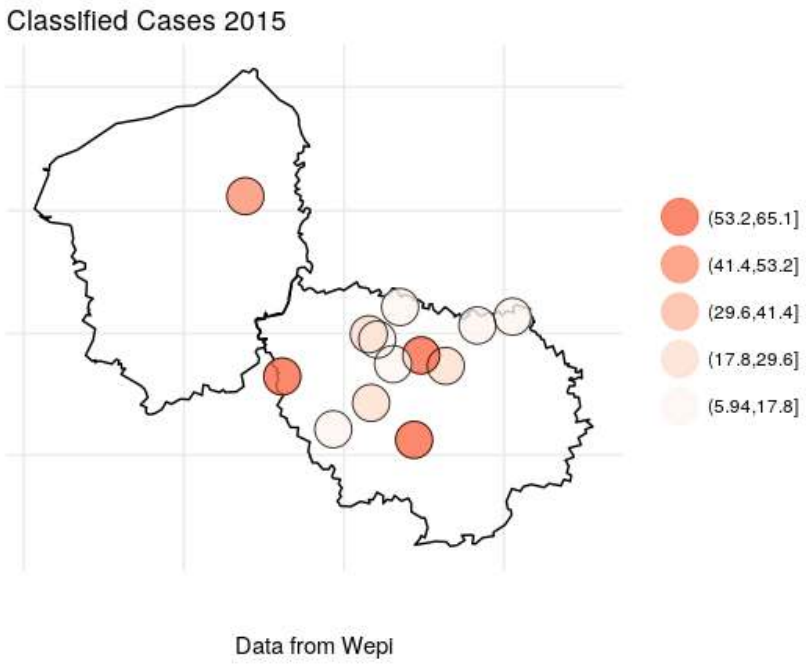

Figure 7: colored points (classification)

```
# Typed points
#-----------------------------------------------------------------------
dots(map, points = W,
     color = "#ee00ee",
     strate="type",
     title="Typed Cases 2015", note="Data from Wepi")
```

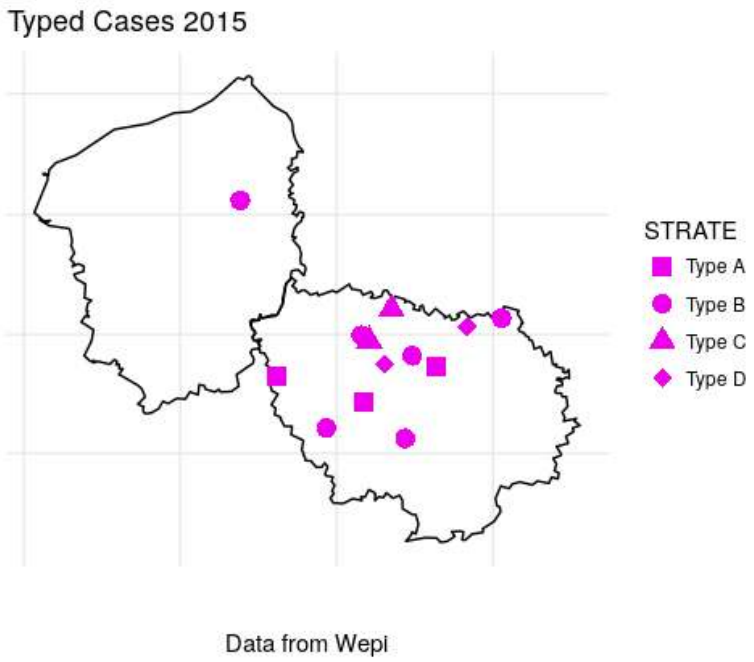

Figure 8: typed points (stratification)

Plotting proportionals dots

propDots()

propDots(

```
        x,

        data,

        value,

        breaks=NULL,

        range=NULL,

        labels=NULL,

        color="red",

        title="",

        note=NULL

    )
```

Parameter	Description
x	**Object** GADMWrapper
data	**Object** data.frame with columns 'latitude' and 'longitude'
value	**Character** Name of a column of the data.frame.
breaks	**vector** of breaks
range	**vector** min, max
labels	**vector** of labels
color	a valid color
title	**Character** The title of the plot
note	**Character** A note associated with the plot

Examples

```
library(GADMTools)
library(sp)

France = gadm.loadCountries("FRA", level=1, simplify=0.01)
Region = subset(France, regions=c("Île-de-France","Haute-Normandie"), level=1)

W <- read.csv2("wepi.csv")
W$lieux_lat <- as.double(as.character(W$lieux_lat))
W$lieux_long <- as.double(as.character(W$lieux_long))
W <- rename(W, latitude = lieux_lat, longitude = lieux_long)


# Test of propDots with default parameters
# ------------------------------------------------------------------------------
propDots( Region,
          data = W,
          value = "comptage",
          color="blue",
          note="Test of propDots with default parameters")
```

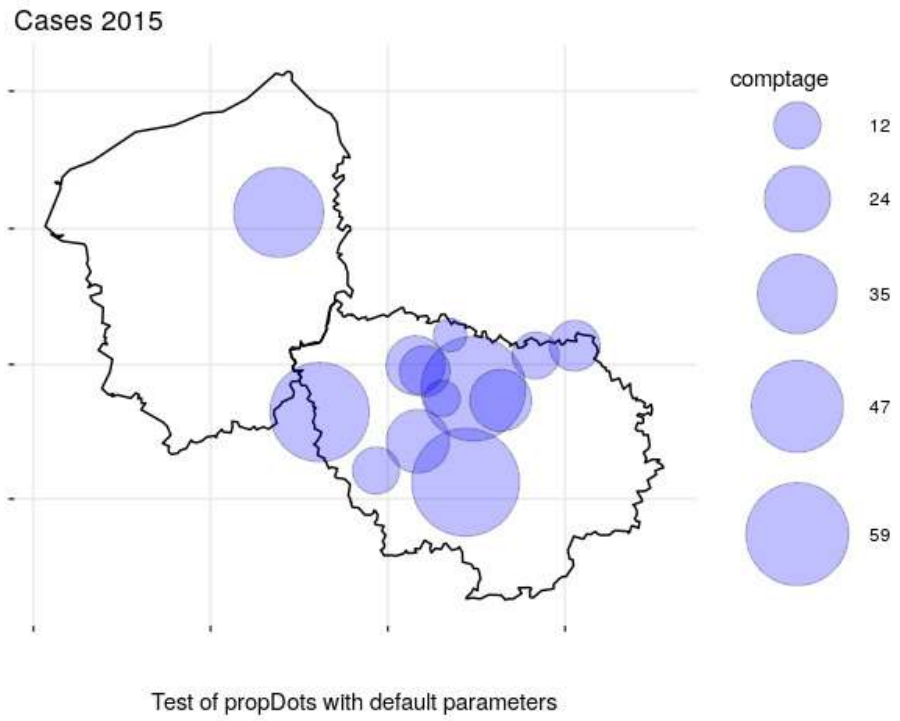

Figure 9: proportional dots with default parameters

```r
# Test of propDots with default parameters
# ------------------------------------------------------------------------
propDots(Region, data = W, value = "comptage", color="orange",
         breaks=c(30, 40, 50, 70, 100),
         title="Cases 2015",
         note="Test of propDots with defined breaks")
```

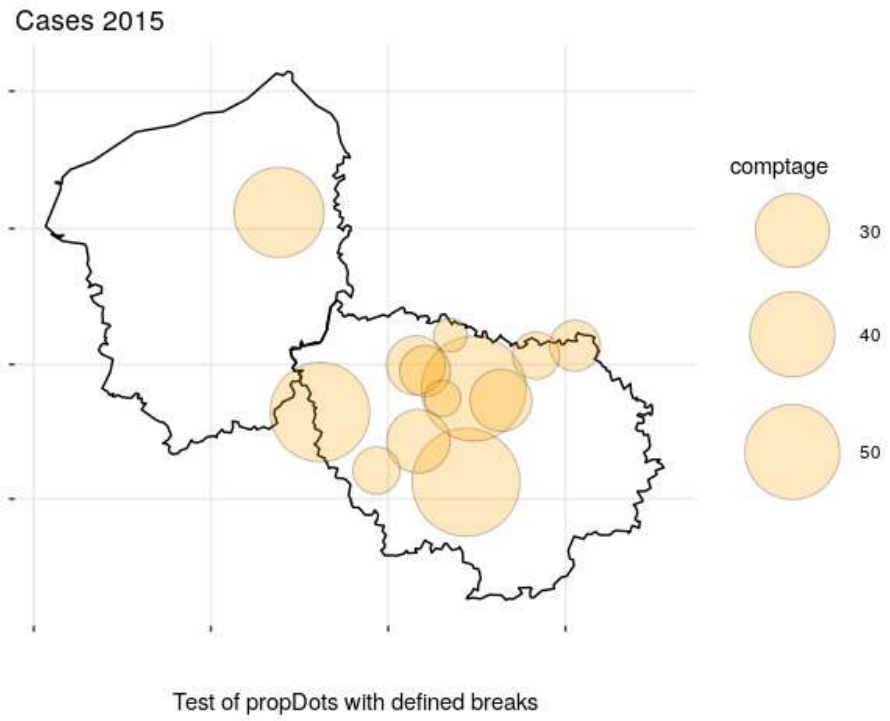

Figure 10: proportional dots with provided breaks

```
propDots(Region, data = W, value = "comptage", color="green",
         range=c(30,70),
         breaks=c(30, 40, 50, 70, 100),
         title="Cases 2015",
         note="Test of propDots with forced range of breaks",
         labels = c("< 30", "30 - 40", "40 - 50", "50 -70", "70 - 100"))
```

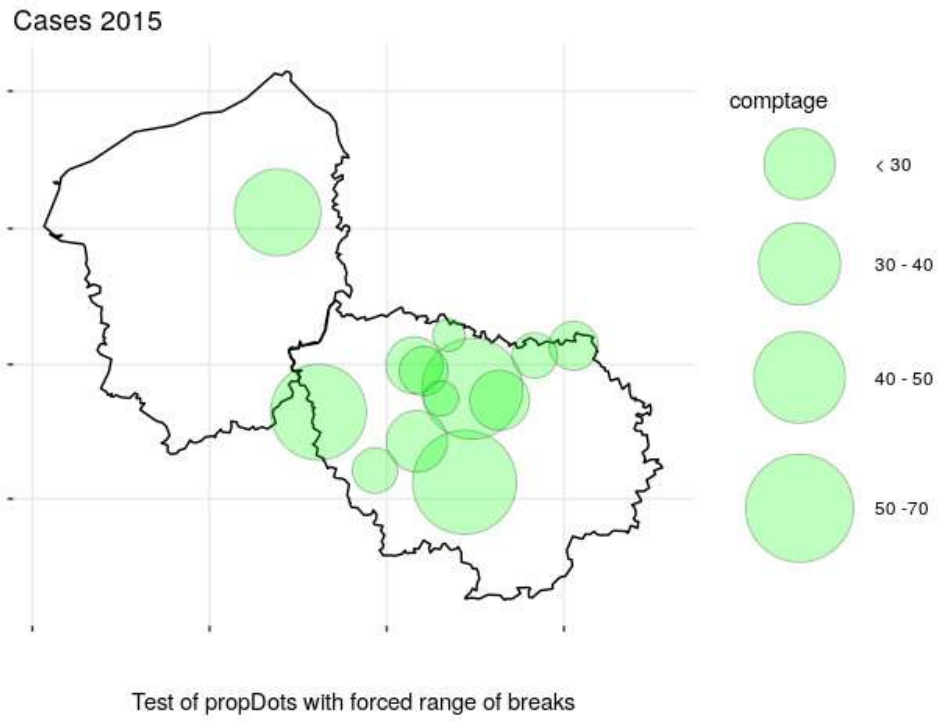

Figure 11: proportional dots with with forced range of breaks

Plotting dots with classified size

classDots()

classDots(

```
        x,

        data, color="red",

        value = NULL,

        breaks = NULL,

        steps = 5,

        labels = NULL,

        opacity = 0.5,

        title="",

        note=NULL,

        legend = NULL

       )
```

Parameter	Description
x	**Object** GADMWrapper
data	**Object** data.frame with columns 'latitude' and 'longitude'
color	a valid color
value	**Character** Name of a column in the data.frame.
breaks	vector of breaks
steps	unused
labels	**Character vector** of labels
opacity	**float** Background opacity of the filled circles
title	**Character** The title of the plot
note	**Character** Add an annotation
legend	**Character** The title of the legend

Exemple

```
library(GADMTools)
library(sp)

France = gadm.loadCountries("FRA", level=1, simplify=0.01)
Region = subset(France, regions=c("Île-de-France","Haute-Normandie"), level=1)

W <- read.csv2("wepi.csv")
W$lieux_lat <- as.double(as.character(W$lieux_lat))
W$lieux_long <- as.double(as.character(W$lieux_long))
W <- rename(W, latitude = lieux_lat, longitude = lieux_long)

classDots(Region,               # Polygons
          data = W,             # Dataset
          value = "comptage",   # Varname
          color="#ff9900",
          breaks=c(1, 10, 30, 50, 60, 100),
          legend = "Emergency",
          title = "Classes of points",
          opacity = 0.6,
          note = "Cases 2015"
)
```

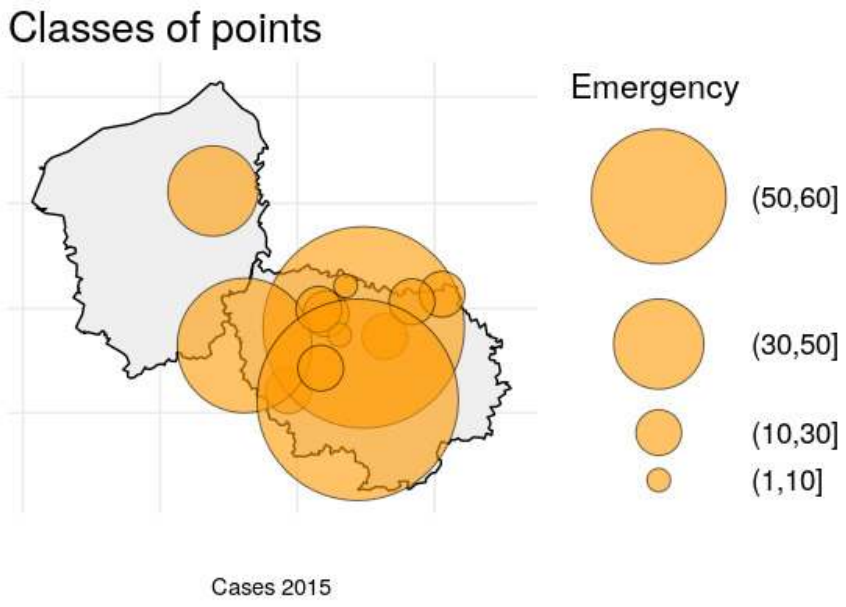

Figure 12: classified dots size

Plotting density

isopleth()

isopleth(x,

```
       data,

       palette=NULL,

       title=""
      )
```

Parameter	Description
x	**Object** GADMWrapper
data	**data.frame** - data to plot
palette	**String** - An RColorBrewer palette name or a String vector vector of colors. Default NULL.
title	**String** - Plot title. Default is an empty string.

Example

```
library(GADMTools)
library(sp)

France = gadm.loadCountries("FRA", level=1, simplify=0.01)
W <- read.csv2("wepi.csv")
W$lieux_lat <- as.double(as.character(W$lieux_lat))
W$lieux_long <- as.double(as.character(W$lieux_long))
colnames(W)[1] <- "latitude"
colnames(W)[2] <- "longitude"
Region = subset(France, regions=c("Île-de-France","Haute-Normandie"), level=1)
isopleth(Region, W)
```

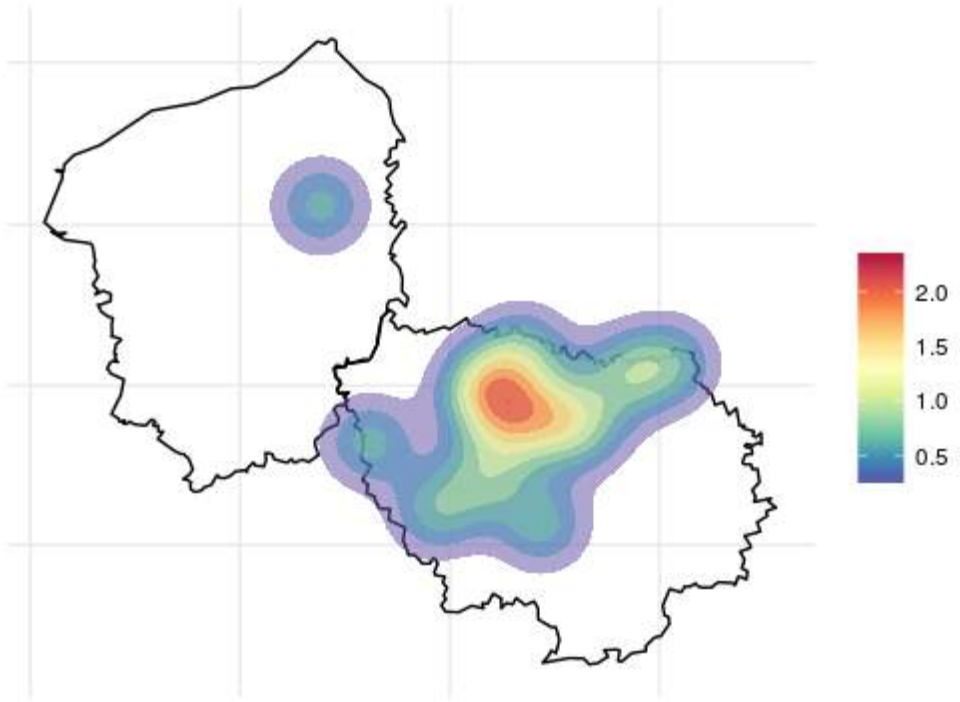

Figure 13: a density plot (isopleth)

Plotting a choropleth

choropleth()

choropleth(

```
x, data, value=NULL, breaks = NULL, steps = 5,

adm.join=NULL, legend = NULL,

labels = NULL, palette=NULL, title=""

)
```

Parameter	Description
x	**Object** GADMWrapper
data	**data.frame** - data to plot
value	**String** - the name of the column in the data.frame we want to plot (eg: an incidence in epidemiology studies)
breaks	**Vector** of breaks values or a **Sring** name of a function from *classIntervals* (one of "sd", "equal", "pretty", "quantile", "kmeans", "hclust", "bclust", "fisher", or "jenks").
steps	**Integer** - number of breaks. Default = 5. If breaks is NOT NULL this value is used internally with cut().
adm.join	**String** - the name in GADM spdf dataset which will be joined with a column of the data.
legend	**String** - legend title. Default NULL.
labels	**String** vector labels for the legend. Default NULL
palette	**String** - An RColorBrewer palette name or a String vector vector of colors. Default NULL.
title	**String** - Title of the plot. Default is an empty string.

Example

```
library(GADMTools)
library(sp)
library(dplyr)

MAP <- gadm.loadCountries("BEL", level = 3, simplify=0.01)
DAT = read.csv2("BE_clamydia_incidence.csv")

# Rewriting District names
# ------------------------
DAT$district <- as.character(DAT$district)
DAT[7,1] = "Brussel"
DAT[20,1] <- "Liège"
DAT[22,1] = "Marche-en-Famenne"
DAT[27,1] = "Neufchâteau"

# Here is the main trick !
# ------------------------------------------------------
DAT <- rename(DAT, NAME_3 = district)

choropleth(MAP, DAT,
           adm.join = "NAME_3",
           value = "rate03",
           breaks = "sd",
           palette="Oranges", legend = "Incidence",
           title="Chlamydia incidence by Belgian district for 2003)")
```

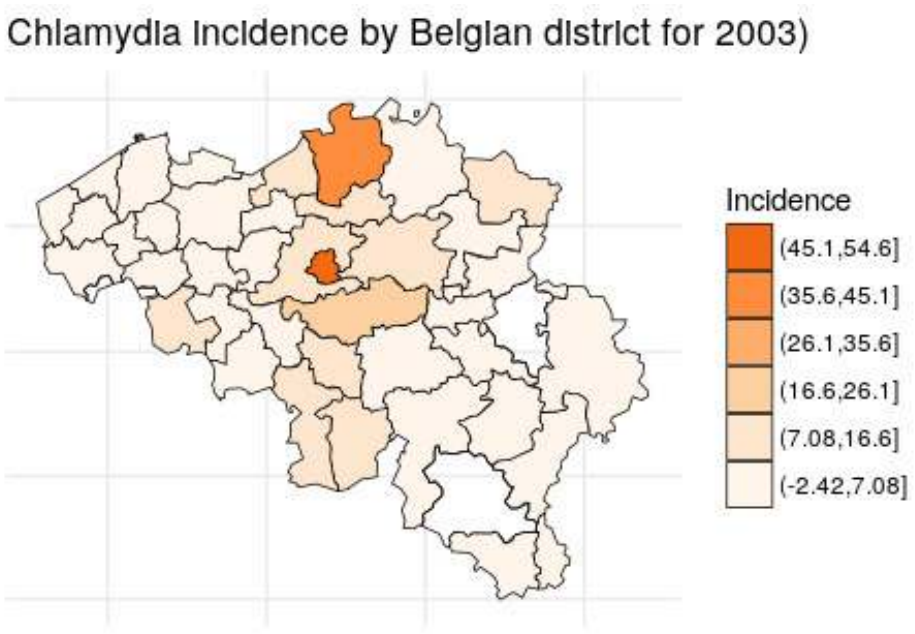

Figure 14: drawing a choropleth

fast.choropleth()

fast.choropleth(

```
x, data, value=NULL,

breaks = NULL, steps = 5,

adm.join=NULL, legend = NULL,

labels = NULL,

palette=NULL, title=""

)
```

Parameter	Description
x	**Object** GADMWrapper
data	**data.frame** - data to plot
value	**String** - the name of the column in the data.frame we want to plot (eg: an incidence in epidemiology studies)
breaks	
steps	**Integer** - number of breaks. Default = 5. If breaks is NOT NULL this value is used internally with cut().
adm.join	**String** - the name in GADM spdf dataset which will be joined with a column of the data.
legend	**String** - legend title. Default NULL.
labels	**String vector** labels for the legend. Default NULL
palette	**String** - An RColorBrewer palette name or a String vector vector of colors. Default NULL.
title	**String** - Title of the plot. Default is an empty string.

Example

```
MAP <- gadm.loadCountries("BEL", level = 3, simplify=0.01)
DAT = read.csv2("BE_clamydia_incidence.csv")

# Rewriting District names
# -----------------------
DAT$district <- as.character(DAT$district)
DAT[7,1] = "Brussel"
DAT[20,1] <- "Liège"
DAT[22,1] = "Marche-en-Famenne"
DAT[27,1] = "Neufchâteau"
DAT <- rename(DAT, NAME_3 = district)


fast.choropleth(MAP, DAT,
                adm.join = "NAME_3",
                value = "rate03",
                steps = 4,
                breaks = "jenks",
                palette="Greens",
                legend = "Incidence",
                title="Chlamydia incidence by Belgian district (2003)")
```

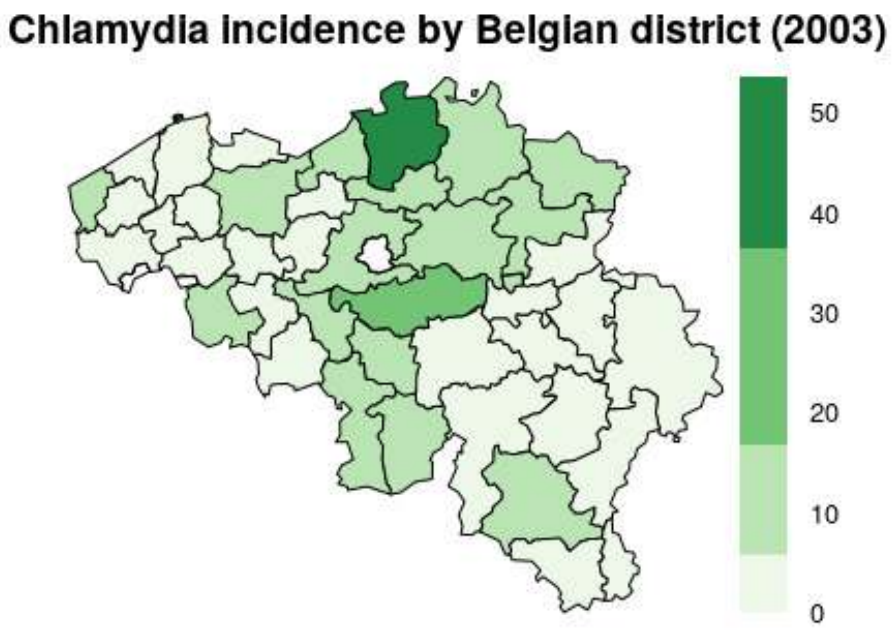

Figure 15: drawing a fast.choropleth