E04

R語言畫地圖 (Maps)

以臺北市各行政區重要統計指標為例

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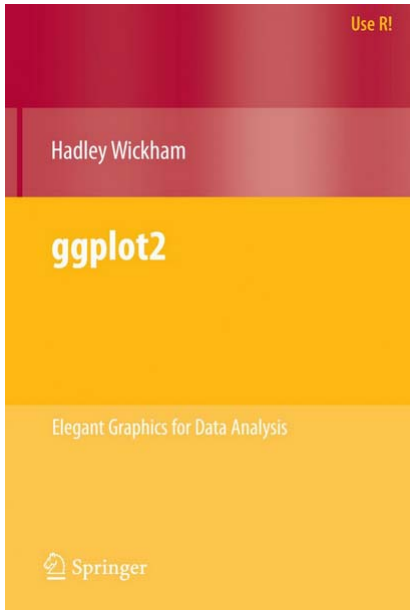
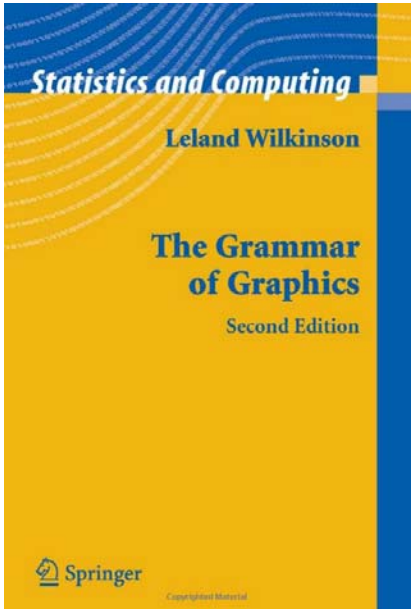
What is ggplot2





- High-level graphics system developed by Hadley Wickham.
- Implements grammar of graphics from Leland Wilkinson.
- Streamlines many graphics workflows for complex plots.
- Syntax centered around main **`ggplot`** function.
- Simpler **`qplot`** function provides many shortcuts.

- The principle that a plot: **Plot = data + aesthetics + geometry**
  - **`data`**: a data frame (dataset).
  - **`aesthetics`**:
    - indicates **`x`** and **`y`** variables,
    - tells R how data are displayed in a plot.
      (e.g. color, size and shape of points etc.)
  - **`geometry`**: to the type of graphics
    (bar chart, histogram, box plot, line plot, density plot, dot plot etc.)

What is ggplot2

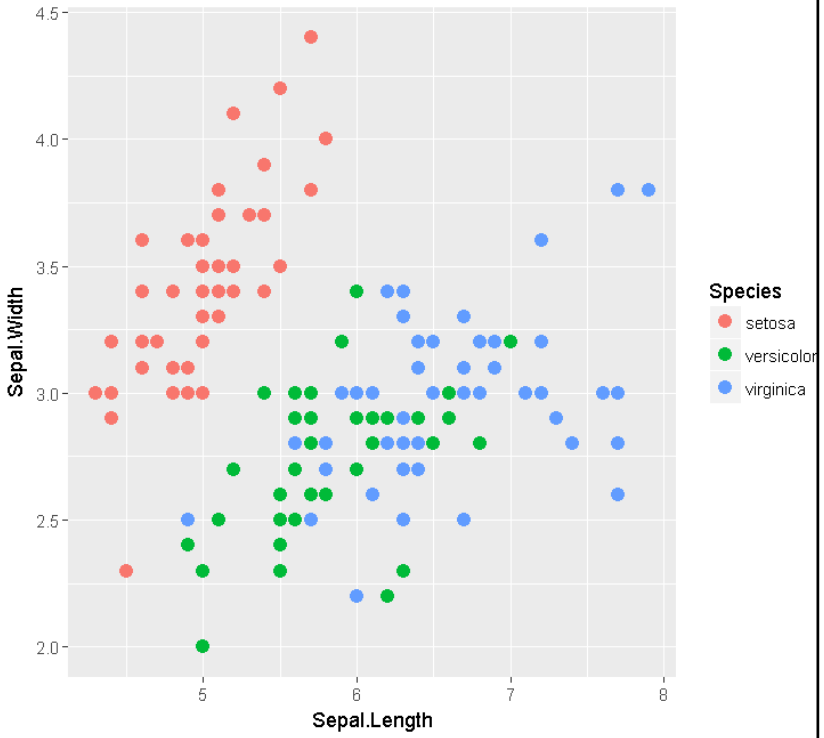
General ggplot syntax

```
ggplot(data, aes(...)) + geom() + ... + stat() + ...
```

```
> install.packages("ggplot2")
> library(ggplot2)
> ggplot(data=iris, aes(x=Sepal.Length, y=Sepal.Width, color=Species)) +
+ geom_point(size=3)
```

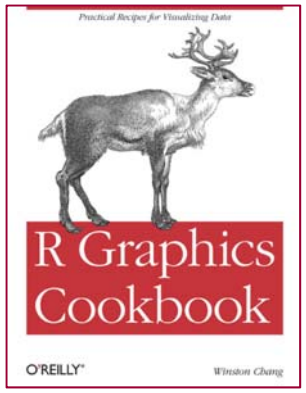
Other important parts of plot:

- **Faceting** implies the same type of graph can be applied to each subset of the data. (e.g, for variable gender, creating 2 graphs for male and female.)
- **Annotation** lets you to add text to the plot.
- **Summary Statistics** allows you to add descriptive statistics on a plot.
- **Scales** are used to control x and y axis limits.



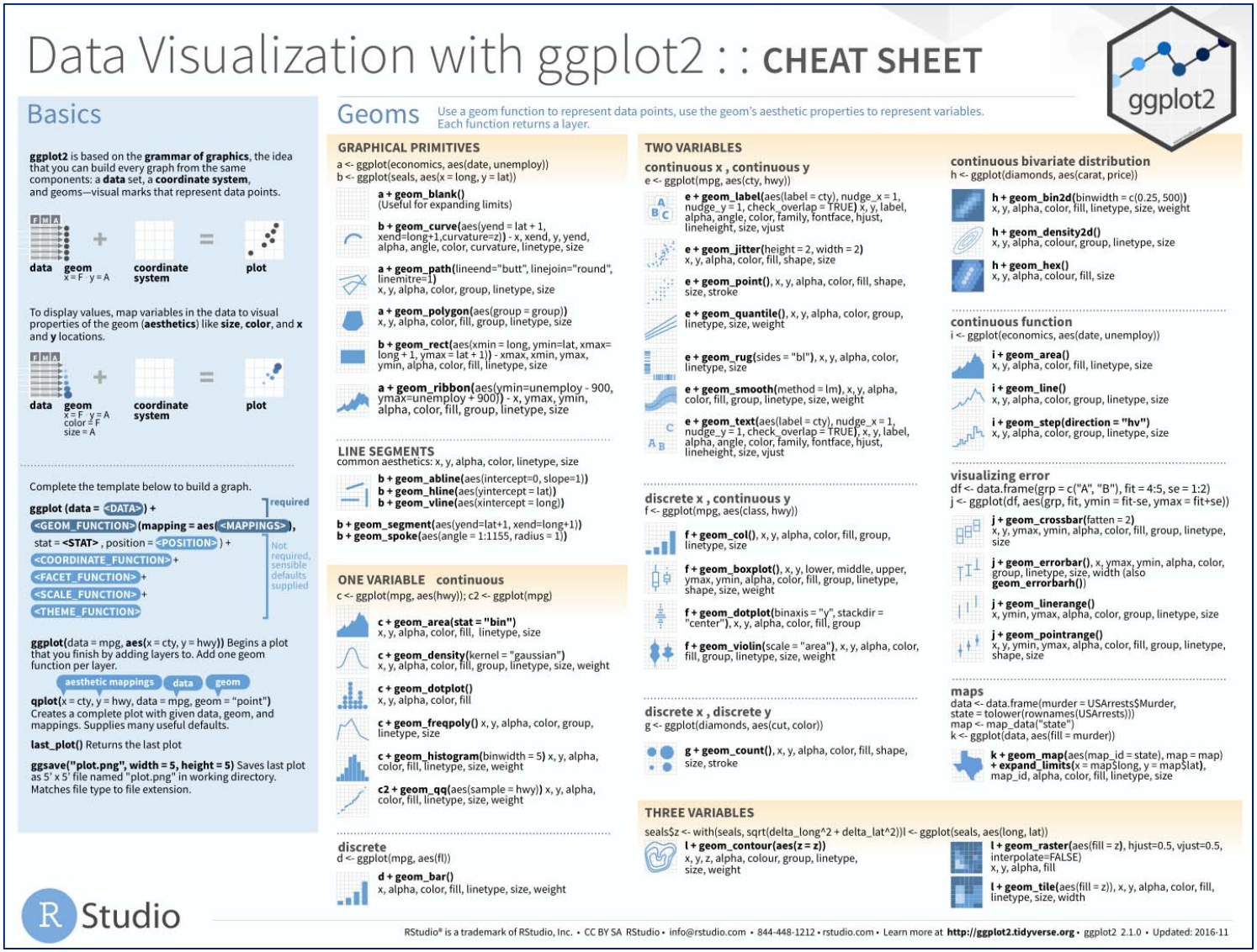
Why ggplot2?

- More elegant & compact code than base graphics.
- More aesthetically pleasing than base graphics.
- Very powerful for exploratory analysis.
- Supports a continuum of expertise.
- Easy to get started, plenty of power for complex figures.
- Publication-quality figures.
- Excellent themes can be created with a single command.
- Its colors are nicer and more pretty than the usual graphics.
- Easy to visualize data with multiple variables.
- Provides a platform to create simple graphs providing plethora of information.



- Manual: http://had.co.nz/ggplot2/
- Introduction: http://www.ling.upenn.edu/~joseff/rstudy/summer2010_ggplot2_intro.html
- Book: http://had.co.nz/ggplot2/book/
- R Graphics Cookbook: http://www.cookbook-r.com/Graphs/

Data Visualization with ggplot2



Data Visualization with ggplot2 : : CHEAT SHEET

ggplot2

Basics

ggplot2 is based on the **grammar of graphics**, the idea that you can build every graph from the same components: a **data** set, a **coordinate system**, and geoms—visual marks that represent data points.

data **geom** x = F, y = A + **coordinate system** = **plot**

To display values, map variables in the data to visual properties of the geom (**aesthetics**) like **size**, **color**, and **x** and **y** locations.

data **geom** x = F, y = A, color = F, size = A + **coordinate system** = **plot**

Complete the template below to build a graph.

```
ggplot (data = <DATA>) +
<GEOM_FUNCTION> (mapping = aes(<MAPPINGS>),
  stat = <STAT>, position = <POSITION>) +
<COORDINATE_FUNCTION> +
<FACET_FUNCTION> +
<SCALE_FUNCTION> +
<THEME_FUNCTION>
```

required

Not required, sensible defaults supplied

ggplot(data = mpg, **aes(**x = cty, y = hwy**))** Begins a plot that you finish by adding layers to. Add one geom function per layer.

aesthetic mappings, data, geom

qplot(x = cty, y = hwy, data = mpg, geom = "point"**)** Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

last_plot() Returns the last plot

ggsave("plot.png", width = 5, height = 5) Saves last plot as 5' x 5' file named "plot.png" in working directory. Matches file type to file extension.

Geoms

Use a geom function to represent data points, use the geom's aesthetic properties to represent variables. Each function returns a layer.

GRAPHICAL PRIMITIVES

a <- ggplot(economics, aes(date, unemploy))
b <- ggplot(seals, aes(x = long, y = lat))

a + geom_blank() (Useful for expanding limits)

b + geom_curve(aes(yend = lat + 1, xend=long+1,curvature=z)**)** - x, xend, y, yend, alpha, angle, color, curvature, linetype, size

a + geom_path(lineend="butt", linejoin="round", linemitre=1**)** x, y, alpha, color, group, linetype, size

a + geom_polygon(aes(group = group)**)** x, y, alpha, color, fill, group, linetype, size

b + geom_rect(aes(xmin = long, ymin=lat, xmax= long + 1, ymax = lat + 1)**)** - xmax, xmin, ymax, ymin, alpha, color, fill, linetype, size

a + geom_ribbon(aes(ymin=unemploy - 900, ymax=unemploy + 900)**)** - x, ymax, ymin, alpha, color, fill, group, linetype, size

LINE SEGMENTS

common aesthetics: x, y, alpha, color, linetype, size

b + geom_abline(aes(intercept=0, slope=1)**)**
b + geom_hline(aes(yintercept = lat)**)**
b + geom_vline(aes(xintercept = long)**)**

b + geom_segment(aes(yend=lat+1, xend=long+1)**)**
b + geom_spoke(aes(angle = 1:1155, radius = 1)**)**

ONE VARIABLE continuous

c <- ggplot(mpg, aes(hwy)); c2 <- ggplot(mpg)

c + geom_area(stat = "bin") x, y, alpha, color, fill, linetype, size

c + geom_density(kernel = "gaussian"**)** x, y, alpha, color, fill, group, linetype, size, weight

c + geom_dotplot() x, y, alpha, color, fill

c + geom_freqpoly() x, y, alpha, color, group, linetype, size

c + geom_histogram(binwidth = 5**)** x, y, alpha, color, fill, linetype, size, weight

c2 + geom_qq(aes(sample = hwy)**)** x, y, alpha, color, fill, linetype, size, weight

discrete

d <- ggplot(mpg, aes(fl))

d + geom_bar() x, alpha, color, fill, linetype, size, weight

TWO VARIABLES

continuous x , continuous y

e <- ggplot(mpg, aes(cty, hwy))

e + geom_label(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE**)** x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

e + geom_jitter(height = 2, width = 2**)** x, y, alpha, color, fill, shape, size

e + geom_point(), x, y, alpha, color, fill, shape, size, stroke

e + geom_quantile(), x, y, alpha, color, group, linetype, size, weight

e + geom_rug(sides = "bl"**)**, x, y, alpha, color, linetype, size

e + geom_smooth(method = lm**)**, x, y, alpha, color, fill, group, linetype, size, weight

e + geom_text(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE**)**, x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

discrete x , continuous y

f <- ggplot(mpg, aes(class, hwy))

f + geom_col(), x, y, alpha, color, fill, group, linetype, size

f + geom_boxplot(), x, y, lower, middle, upper, ymax, ymin, alpha, color, fill, group, linetype, shape, size, weight

f + geom_dotplot(binaxis = "y", stackdir = "center"**)**, x, y, alpha, color, fill, group

f + geom_violin(scale = "area"**)**, x, y, alpha, color, fill, group, linetype, size, weight

discrete x , discrete y

g <- ggplot(diamonds, aes(cut, color))

g + geom_count(), x, y, alpha, color, fill, shape, size, stroke

continuous bivariate distribution

h <- ggplot(diamonds, aes(carat, price))

h + geom_bin2d(binwidth = c(0.25, 500)**)** x, y, alpha, color, fill, linetype, size, weight

h + geom_density2d() x, y, alpha, colour, group, linetype, size

h + geom_hex() x, y, alpha, colour, fill, size

continuous function

i <- ggplot(economics, aes(date, unemploy))

i + geom_area() x, y, alpha, color, fill, linetype, size

i + geom_line() x, y, alpha, color, group, linetype, size

i + geom_step(direction = "hv") x, y, alpha, color, group, linetype, size

visualizing error

df <- data.frame(grp = c("A", "B"), fit = 4:5, se = 1:2)
j <- ggplot(df, aes(grp, fit, ymin = fit-se, ymax = fit+se))

j + geom_crossbar(fatten = 2**)** x, y, ymax, ymin, alpha, color, fill, group, linetype, size

j + geom_errorbar(), x, ymax, ymin, alpha, color, group, linetype, size, width (also **geom_errorbarh()**)

j + geom_linerange() x, ymin, ymax, alpha, color, group, linetype, size

j + geom_pointrange() x, y, ymin, ymax, alpha, color, fill, group, linetype, shape, size

maps

data <- data.frame(murder = USArrests$Murder, state = tolower(rownames(USArrests)))
map <- map_data("state")
k <- ggplot(data, aes(fill = murder))

k + geom_map(aes(map_id = state), map = map**)** **+ expand_limits(**x = map$long, y = map$lat**)**, map_id, alpha, color, fill, linetype, size

THREE VARIABLES

seals$z <- with(seals, sqrt(delta_long^2 + delta_lat^2))l <- ggplot(seals, aes(long, lat))

l + geom_contour(aes(z = z)) x, y, z, alpha, colour, group, linetype, size, weight

l + geom_raster(aes(fill = z), hjust=0.5, vjust=0.5, interpolate=FALSE**)** x, y, alpha, fill

l + geom_tile(aes(fill = z)**)**, x, y, alpha, color, fill, linetype, size, width

RStudio

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https://www.rstudio.com/resources/cheatsheets/

Data Visualization with ggplot2

Stats An alternative way to build a layer

A stat builds new variables to plot (e.g., count, prop).

Visualize a stat by changing the default stat of a geom function, **geom_bar(stat="count")** or by using a stat function, **stat_count(geom="bar")**, which calls a default geom to make a layer (equivalent to a geom function). Use **..name..** syntax to map stat variables to aesthetics.

i + stat_density2d(aes(fill = ..level..), geom = "polygon")

geom to use | stat function | geommappings | variable created by stat

c + stat_bin(binwidth = 1, origin = 10)
x, y | ..count.., ..ncount.., ..density.., ..ndensity..

c + stat_count(width = 1) **x, y,** | ..count.., ..prop..

c + stat_density(adjust = 1, kernel = "gaussian")
x, y, | ..count.., ..density.., ..scaled..

e + stat_bin_2d(bins = 30, drop = T)
x, y, fill | ..count.., ..density..

e + stat_bin_hex(bins=30) **x, y, fill** | ..count.., ..density..

e + stat_density_2d(contour = TRUE, n = 100)
x, y, color, size | ..level..

e + stat_ellipse(level = 0.95, segments = 51, type = "t")

l + stat_contour(aes(z = z)) **x, y, z, order** | ..level..

l + stat_summary_hex(aes(z = z), bins = 30, fun = max)
x, y, z, fill | ..value..

l + stat_summary_2d(aes(z = z), bins = 30, fun = mean)
x, y, z, fill | ..value..

f + stat_boxplot(coef = 1.5) **x, y** | ..lower.., ..middle.., ..upper.., ..width.. , ..ymin.., ..ymax..

f + stat_ydensity(kernel = "gaussian", scale = "area") **x, y** | ..density.., ..scaled.., ..count.., ..n.., ..violinwidth.., ..width..

e + stat_ecdf(n = 40) **x, y** | ..x.., ..y..

e + stat_quantile(quantiles = c(0.1, 0.9), formula = y ~ log(x), method = "rq") **x, y** | ..quantile..

e + stat_smooth(method = "lm", formula = y ~ x, se=T, level=0.95) **x, y** | ..se.., ..x.., ..y.., ..ymin.., ..ymax..

ggplot() + stat_function(aes(x = -3:3), n = 99, fun = dnorm, args = list(sd=0.5)) **x** | ..x.., ..y..

e + stat_identity(na.rm = TRUE)

ggplot() + stat_qq(aes(sample=1:100), dist = qt, dparam=list(df=5)) **sample, x, y** | ..sample.., ..theoretical..

e + stat_sum() x, y, size | ..n.., ..prop..

e + stat_summary(fun.data = "mean_cl_boot")

h + stat_summary_bin(fun.y = "mean", geom = "bar")

e + stat_unique()

Scales

Scales map data values to the visual values of an aesthetic. To change a mapping, add a new scale.

(n <- d + geom_bar(aes(fill = fl)))

scale_ | aesthetic to adjust | prepackaged scale to use | scale-specific arguments

n + scale_fill_manual(
values = c("skyblue", "royalblue", "blue", "navy"),
limits = c("d", "e", "p", "r"), breaks =c("d", "e", "p", "r"),
name = "fuel", labels = c("D", "E", "P", "R"))

range of values to include in mapping | title to use in legend/axis | labels to use in legend/axis | breaks to use in legend/axis

GENERAL PURPOSE SCALES

Use with most aesthetics

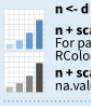
scale_*_continuous() - map cont' values to visual ones
scale_*_discrete() - map discrete values to visual ones
scale_*_identity() - use data values **as** visual ones
scale_*_manual(values = c()) - map discrete values to manually chosen visual ones
scale_*_date(date_labels = "%m/%d"), date_breaks = "2 weeks") - treat data values as dates.
scale_*_datetime() - treat data x values as date times. Use same arguments as scale_x_date(). See ?strptime for label formats.

X & Y LOCATION SCALES

Use with x or y aesthetics (x shown here)

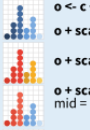
scale_x_log10() - Plot x on log10 scale
scale_x_reverse() - Reverse direction of x axis
scale_x_sqrt() - Plot x on square root scale

COLOR AND FILL SCALES (DISCRETE)



n <- d + geom_bar(aes(fill = fl))
n + scale_fill_brewer(palette = "Blues")
For palette choices:
RColorBrewer::display.brewer.all()
n + scale_fill_grey(start = 0.2, end = 0.8, na.value = "red")

COLOR AND FILL SCALES (CONTINUOUS)



o <- c + geom_dotplot(aes(fill = ..x..))
o + scale_fill_distiller(palette = "Blues")
o + scale_fill_gradient(low="red", high="yellow")
o + scale_fill_gradient2(low="red", high="blue", mid = "white", midpoint = 25)
o + scale_fill_gradientn(colours=topo.colors(6))
Also: rainbow(), heat.colors(), terrain.colors(), cm.colors(), RColorBrewer::brewer.pal()

SHAPE AND SIZE SCALES

p <- e + geom_point(aes(shape = fl, size = cyl))
p + scale_shape() + scale_size()
p + scale_shape_manual(values = c(3:7))
p + scale_radius(range = c(1,6))
p + scale_size_area(max_size = 6)

Coordinate Systems

r <- d + geom_bar()

r + coord_cartesian(xlim = c(0, 5))
xlim, ylim
The default cartesian coordinate system

r + coord_fixed(ratio = 1/2)
ratio, xlim, ylim
Cartesian coordinates with fixed aspect ratio between x and y units

r + coord_flip()
xlim, ylim
Flipped Cartesian coordinates

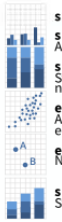
r + coord_polar(theta = "x", direction=1)
theta, start, direction
Polar coordinates

r + coord_trans(ytrans = "sqrt")
xtrans, ytrans, limx, limy
Transformed cartesian coordinates. Set xtrans and ytrans to the name of a window function.

π + coord_quickmap()
π + coord_map(projection = "ortho", orientation=c(41, -74, 0))projection, orienztation, xlim, ylim
Map projections from the mapproj package (mercator (default), azequalarea, lagrange, etc.)

Position Adjustments

Position adjustments determine how to arrange geoms that would otherwise occupy the same space.



s <- ggplot(mpg, aes(fl, fill = drv))
s + geom_bar(position = "dodge")
Arrange elements side by side
s + geom_bar(position = "fill")
Stack elements on top of one another, normalize height
e + geom_point(position = "jitter")
Add random noise to X and Y position of each element to avoid overplotting
e + geom_label(position = "nudge")
Nudge labels away from points
s + geom_bar(position = "stack")
Stack elements on top of one another

Each position adjustment can be recast as a function with manual **width** and **height** arguments
s + geom_bar(position = position_dodge(width = 1))

Themes

r + theme_bw()
White background with grid lines
r + theme_gray()
Grey background (default theme)
r + theme_dark()
dark for contrast

r + theme_classic()
r + theme_light()
r + theme_linedraw()
r + theme_minimal()
Minimal themes
r + theme_void()
Empty theme

Faceting

Facets divide a plot into subplots based on the values of one or more discrete variables.

t <- ggplot(mpg, aes(cty, hwy)) + geom_point()

t + facet_grid(. ~ fl)
facet into columns based on fl
t + facet_grid(year ~ .)
facet into rows based on year
t + facet_grid(year ~ fl)
facet into both rows and columns
t + facet_wrap(~ fl)
wrap facets into a rectangular layout

Set **scales** to let axis limits vary across facets

t + facet_grid(drv ~ fl, scales = "free")
x and y axis limits adjust to individual facets
"free_x" - x axis limits adjust
"free_y" - y axis limits adjust

Set **labeller** to adjust facet labels

t + facet_grid(. ~ fl, labeller = label_both)

fl: c	fl: d	fl: e	fl: p	fl: r

t + facet_grid(fl ~ ., labeller = label_bquote(alpha ^ .(fl)))

α^{c}	α^{d}	α^{e}	α^{p}	α^{r}

t + facet_grid(. ~ fl, labeller = label_parsed)

c	d	e	p	r

Labels

t + labs(**x** = "New x axis label", **y** = "New y axis label",
title ="Add a title above the plot",
subtitle = "Add a subtitle below title",
caption = "Add a caption below plot",
<AES> = "New <AES> legend title")

Use scale functions to update legend labels

t + annotate(geom = "text", x = 8, y = 9, label = "A")

geom to place | manual values for geom's aesthetics

Legends

n + theme(legend.position = "bottom")
Place legend at "bottom", "top", "left", or "right"

n + guides(fill = "none")
Set legend type for each aesthetic: colorbar, legend, or none (no legend)

n + scale_fill_discrete(name = "Title", labels = c("A", "B", "C", "D", "E"))
Set legend title and labels with a scale function.

Zooming

Without clipping (preferred)
t + coord_cartesian(
xlim = c(0, 100), ylim = c(10, 20))

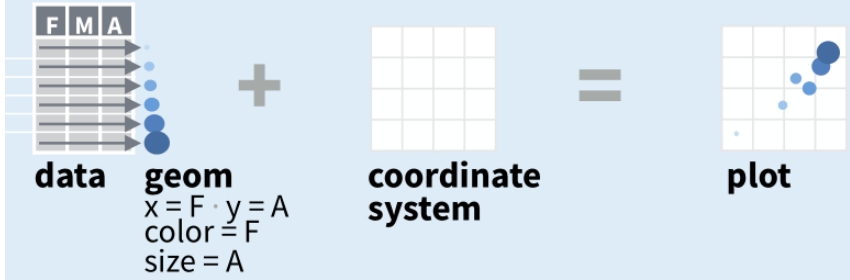
With clipping (removes unseen data points)
t + xlim(0, 100) **+ ylim**(10, 20)
t + scale_x_continuous(limits = c(0, 100)) **+ scale_y_continuous**(limits = c(0, 100))

RStudio

ggplot2 Basics

ggplot2 is based on the **grammar of graphics**, the idea that you can build every graph from the same components: a **data** set, a **coordinate system**, and geoms—visual marks that represent data points.

To display values, map variables in the data to visual properties of the geom (**aesthetics**) like **size**, **color**, and **x** and **y** locations.



Complete the template below to build a graph.

```
ggplot (data = <DATA>) +                          ] required
<GEOM_FUNCTION> (mapping = aes( <MAPPINGS> ),
 stat = <STAT> , position = <POSITION> ) +        ] Not required, sensible defaults supplied
<COORDINATE_FUNCTION> +
<FACET_FUNCTION> +
<SCALE_FUNCTION> +
<THEME_FUNCTION>
```

ggplot(data = mpg, **aes(**x = cty, y = hwy**))** Begins a plot that you finish by adding layers to. Add one geom function per layer.

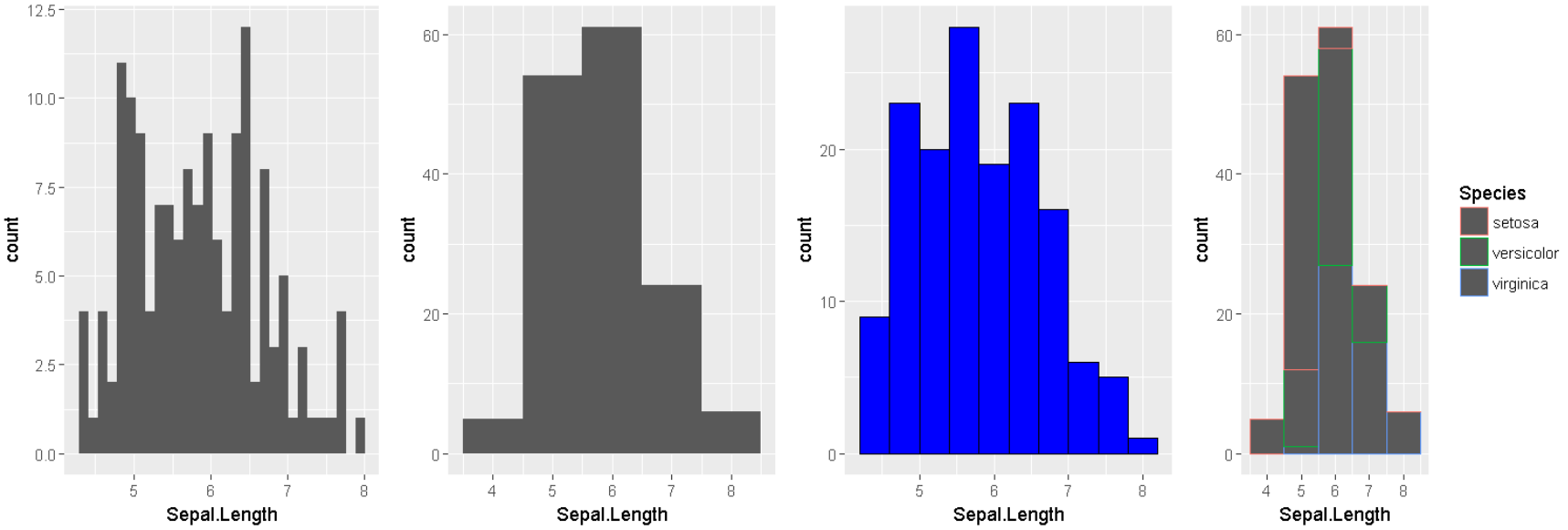
aesthetic mappings | data | geom

qplot(x = cty, y = hwy, data = mpg, geom = "point"**)** Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

geom_histogram()

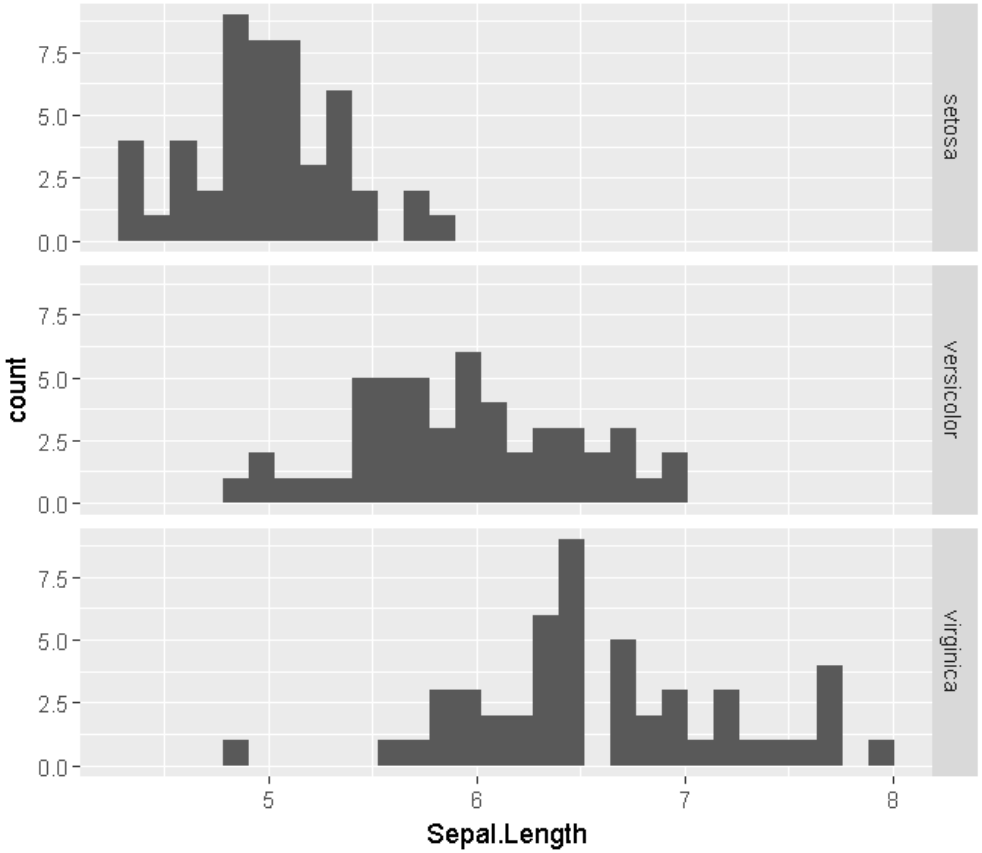
geoms: Use a geom function to represent data points, use the geom's aesthetic properties to represent variables.
Each function returns a layer.

```
> # install.packages("gridExtra")
> library(gridExtra)
> h1 <- ggplot(data=iris, aes(x=Sepal.Length)) + geom_histogram()
> h2 <- ggplot(data=iris, aes(x=Sepal.Length)) + geom_histogram(binwidth=1)
> h3 <- ggplot(data=iris, aes(x=Sepal.Length)) +
        geom_histogram(color="black", fill="blue", bins = 10)
> h4 <- ggplot(data=iris, aes(x=Sepal.Length, color=Species)) + geom_histogram(binwidth = 1)
> grid.arrange(h1, h2, h3, h4, nrow=1, ncol=4)
```



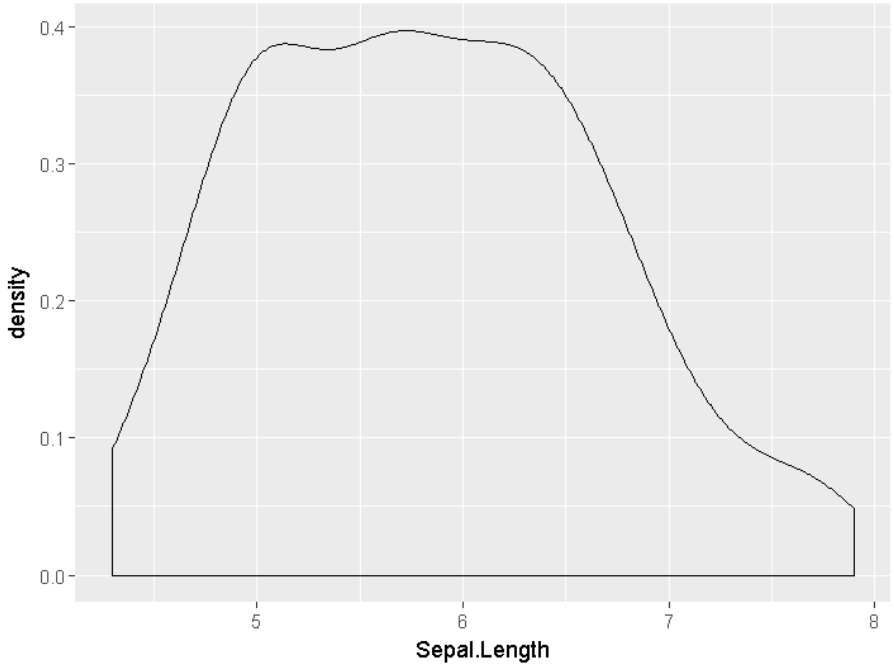
geom_histogram()

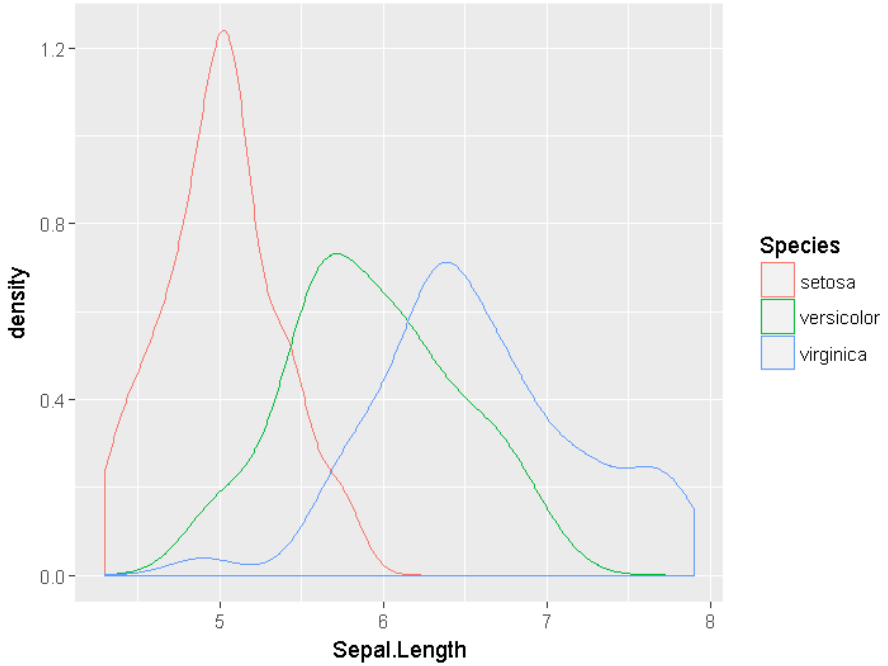
```
> p <- ggplot(data=iris, aes(x=Sepal.Length))
> p <- p + geom_histogram()
> p + facet_grid(Species~.)   #row
```



geom_density()

```
> ggplot(iris, aes(x=Sepal.Length)) + geom_density()
> ggplot(iris, aes(x=Sepal.Length, color=Species)) + geom_density()
> ?geom_density
```





mtcars {datasets}

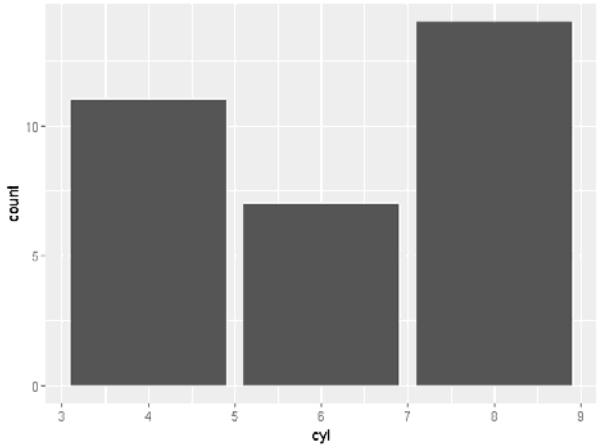
mtcars {datasets}: Motor Trend Car Road Tests, A data frame with 32 observations on 11 variables.

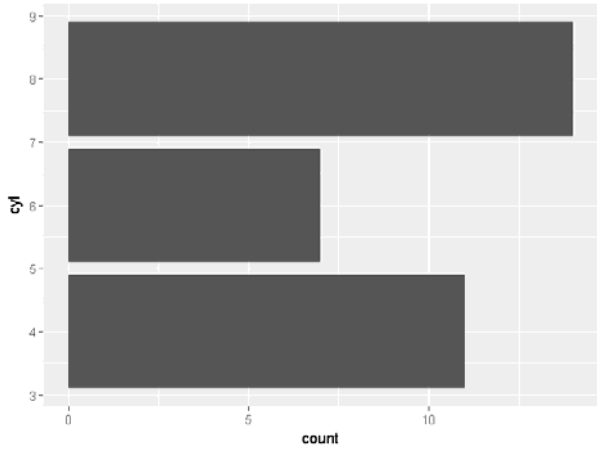
- mpg: Miles/(US) gallon (油耗)
- cyl: Number of cylinders (氣缸)
- disp: Displacement (cu.in.) (單汽缸排氣量)
- hp: Gross horsepower (馬力)
- drat: Rear axle ratio (後軸比)
- wt: Weight (1000 lbs)
- qsec: 1/4 mile time
- vs: V/S
- am: Transmission (0 = automatic, 1 = manual) (自手排)
- gear: Number of forward gears (前進檔的數量)
- carb: Number of carburetors (化油器的數量)

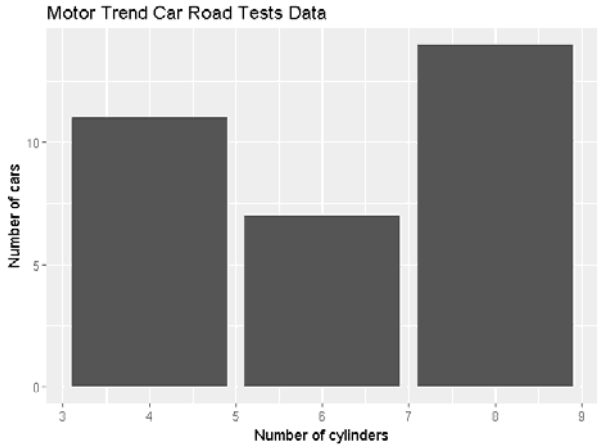
```
> head(mtcars)
                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

geom_bar()

```
> p <- ggplot(mtcars, aes(x= cyl)) + geom_bar()
> p
> ggplot(mtcars, aes(x= cyl)) + geom_bar() + coord_flip()
> p + labs(title = "Motor Trend Car Road Tests Data",
         x = "Number of cylinders", y = "Number of cars")
```



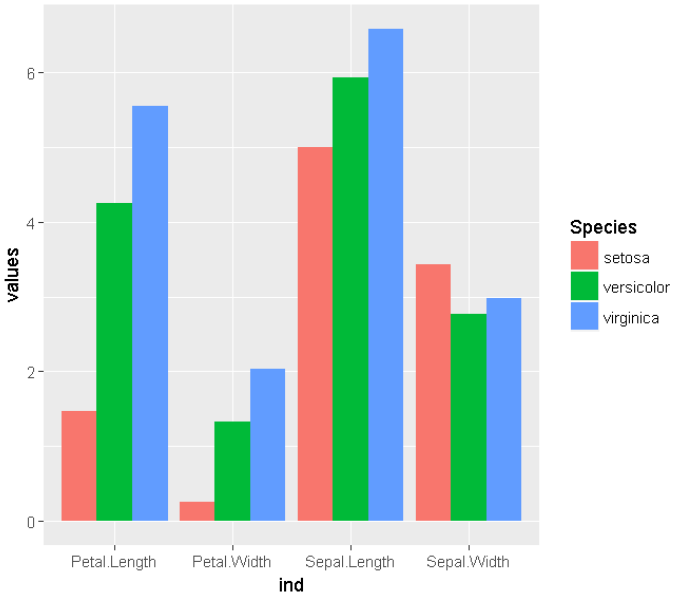




ggtitle("Main title"): Adds a main title above the plot
xlab("X axis label"): Changes the X axis label
ylab("Y axis label"): Changes the Y axis label
labs(title = "Main title", x = "X axis label", y = "Y axis label"): Changes main title and axis labels

geom_bar()

```
> iris.mean <- aggregate(iris[,1:4], by=list(Species=iris$Species), FUN=mean)
> iris.mean
     Species Sepal.Length Sepal.Width Petal.Length Petal.Width
1     setosa        5.006       3.428        1.462       0.246
2 versicolor        5.936       2.770        4.260       1.326
3  virginica        6.588       2.974        5.552       2.026
> mydata <- cbind(stack(iris.mean[,-1]), Species = iris.mean$Species)
> mydata
   values          ind    Species
1   5.006 Sepal.Length     setosa
2   5.936 Sepal.Length versicolor
3   6.588 Sepal.Length  virginica
4   3.428  Sepal.Width     setosa
5   2.770  Sepal.Width versicolor
6   2.974  Sepal.Width  virginica
7   1.462 Petal.Length     setosa
8   4.260 Petal.Length versicolor
9   5.552 Petal.Length  virginica
10  0.246  Petal.Width     setosa
11  1.326  Petal.Width versicolor
12  2.026  Petal.Width  virginica
> ggplot(mydata, aes(x=ind, y=values, fill = Species)) +
+   geom_bar(position="dodge", stat="identity")
```

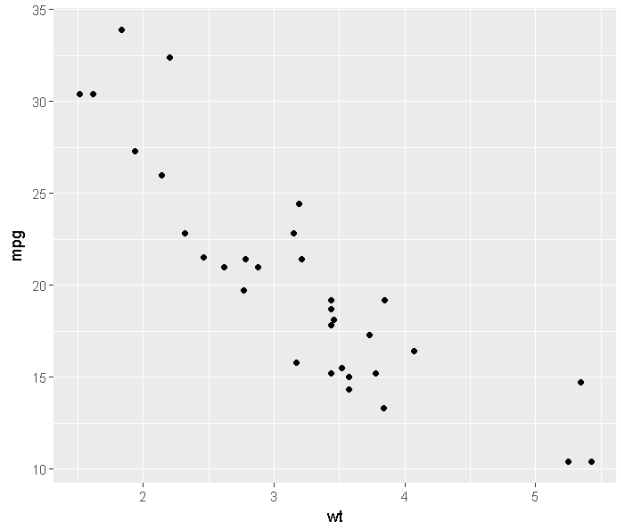


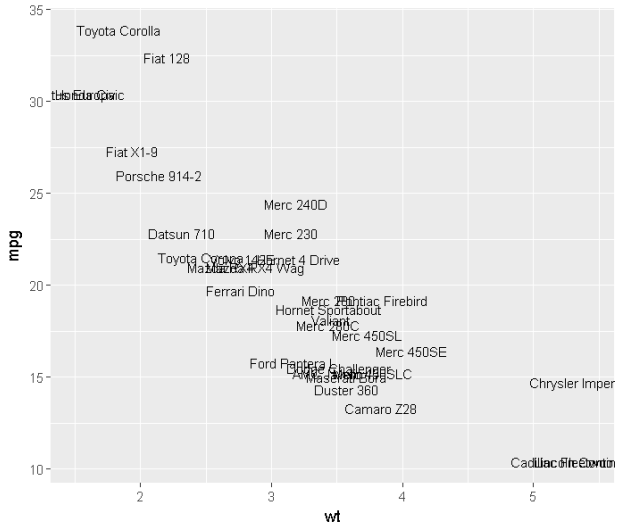
position_dodge for creating side-by-side barcharts.

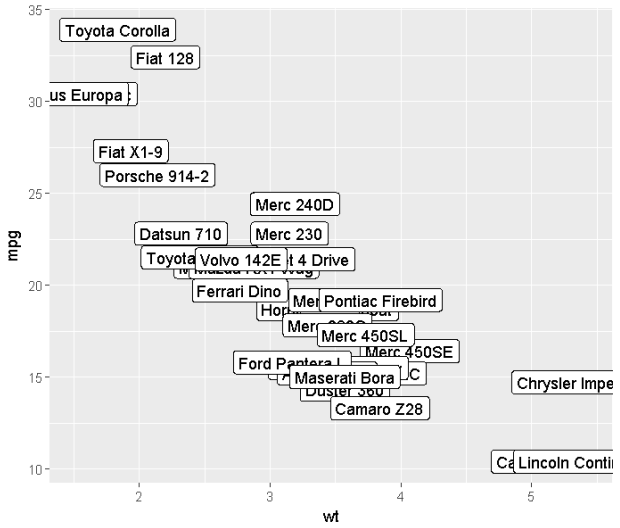
Other position adjustments: **position_identity, position_jitterdodge, position_jitter, position_nudge, position_stack**

geom_text

```
> p <- ggplot(data=mtcars, aes(x=wt, y=mpg, label = rownames(mtcars)))
> p + geom_point()
> p + geom_text(size=3)
> p + geom_label()
```



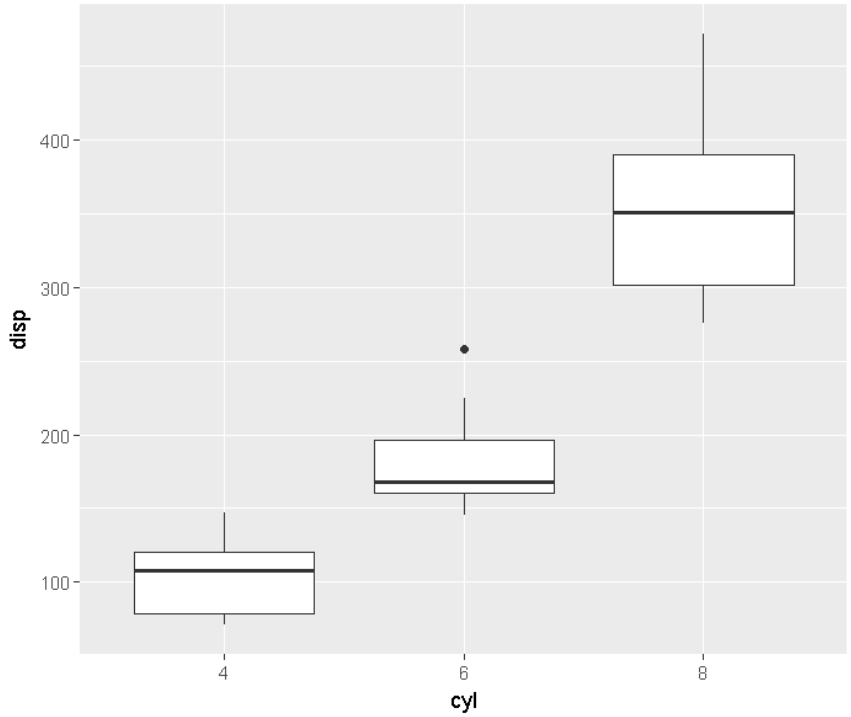




geom_text understands the following aesthetics (required aesthetics are in bold):
x, y, label, alpha, angle, colour, family, fontface, group, hjust, lineheight, size, vjust

geom_boxplot()

```
> mtcars$cyl <- factor(mtcars$cyl)
> ggplot(data=mtcars, aes(x=cyl, y=disp)) + geom_boxplot()
```

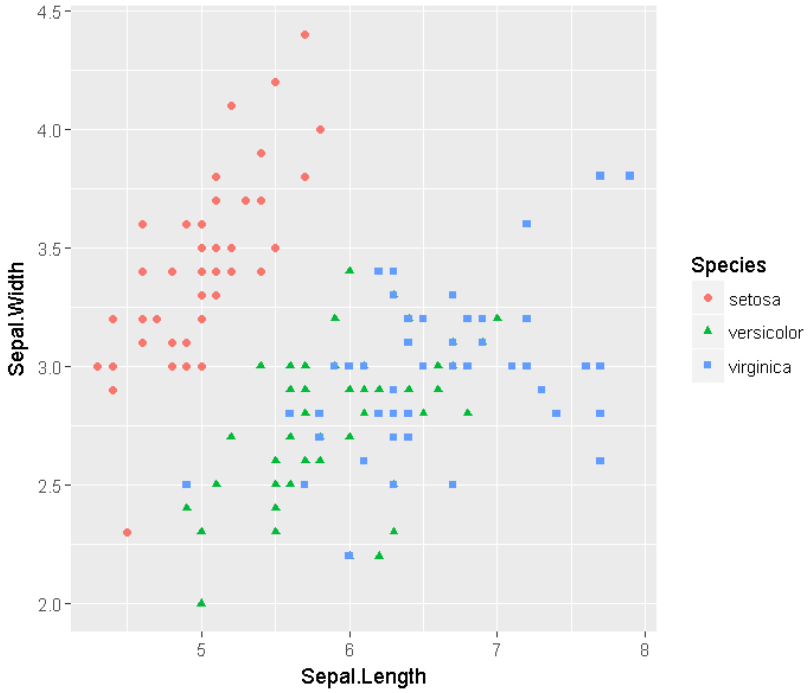


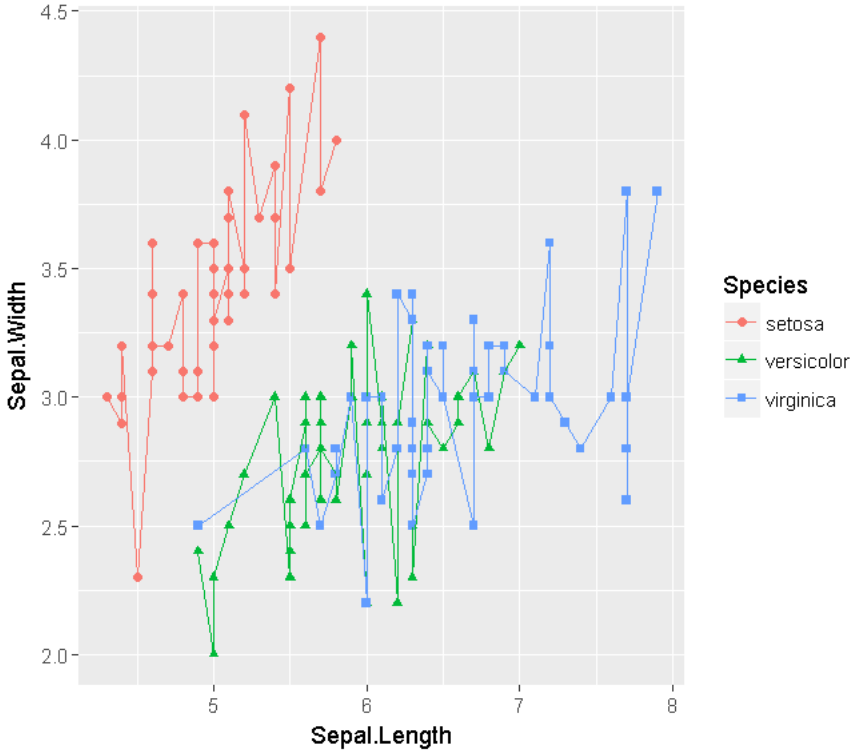
geom_boxplot understands the following aesthetics (required aesthetics are in bold):
x, lower, upper, middle, ymin, ymax, alpha, colour, fill, group, linetype, shape, size, weight

geom_point()

```
> ggplot(data=iris, aes(x=Sepal.Length, y=Sepal.Width,
      shape=Species, color=Species)) +
> geom_point()
```

```
> p <- ggplot(data=iris, aes(x=Sepal.Length, y=Sepal.Width, shape=Species, color=Species))
> p <- p + geom_point()
> p
> p + geom_line(aes(y=Sepal.Width))
```



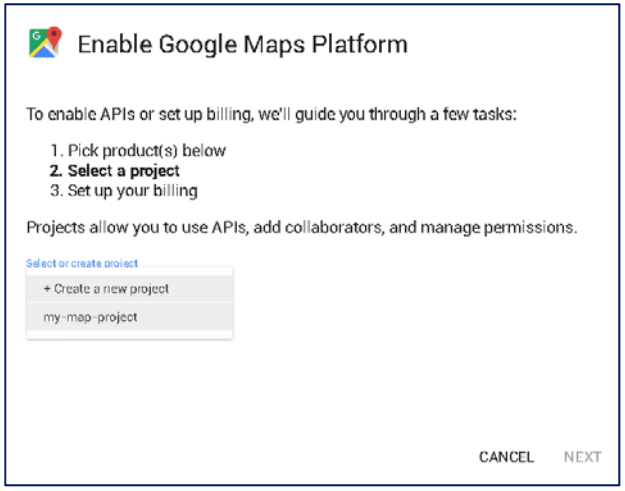


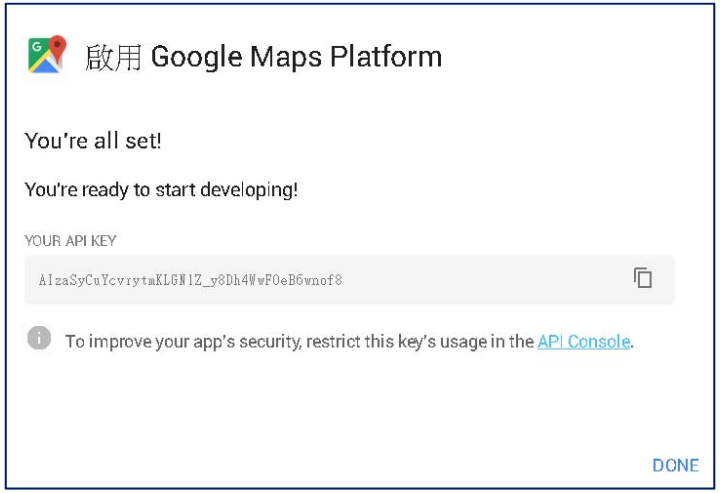
使用Google雲端服務

 # step1: Get API Key
https://cloud.google.com/maps-platform/
https://developers.google.com/maps/documentation/maps-static/get-api-key
 # Step2: Enable Billing
https://console.cloud.google.com/project/_/billing/enable

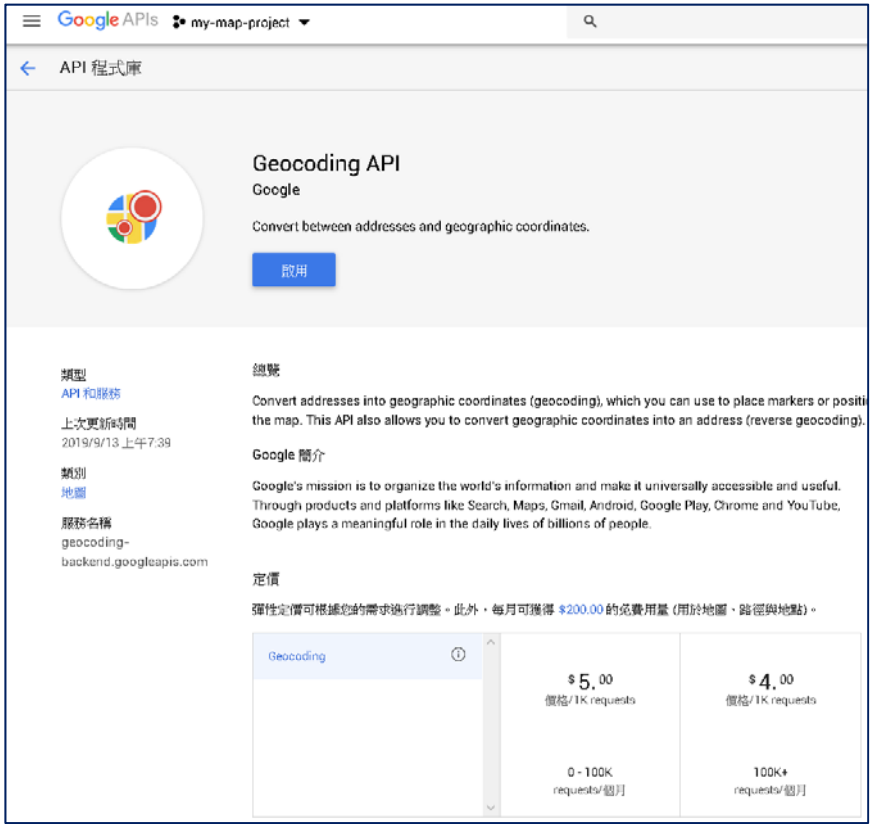
As of mid-2018, the Google Maps Platform requires a registered API key.

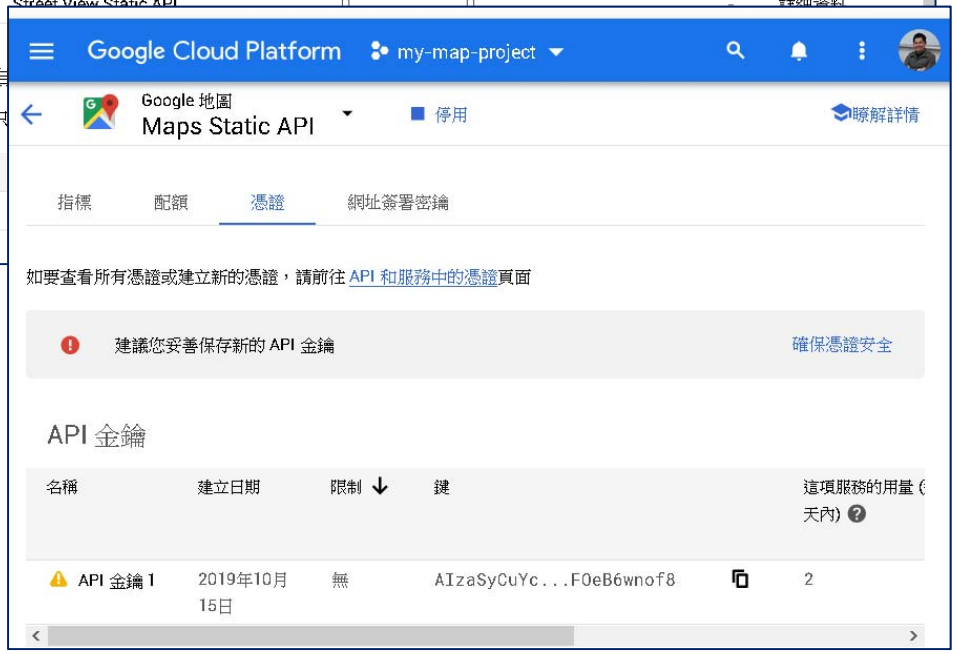
Google Cloud Platform





使用Google雲端服務





Plotting on Google Static Maps in R: RgoogleMaps

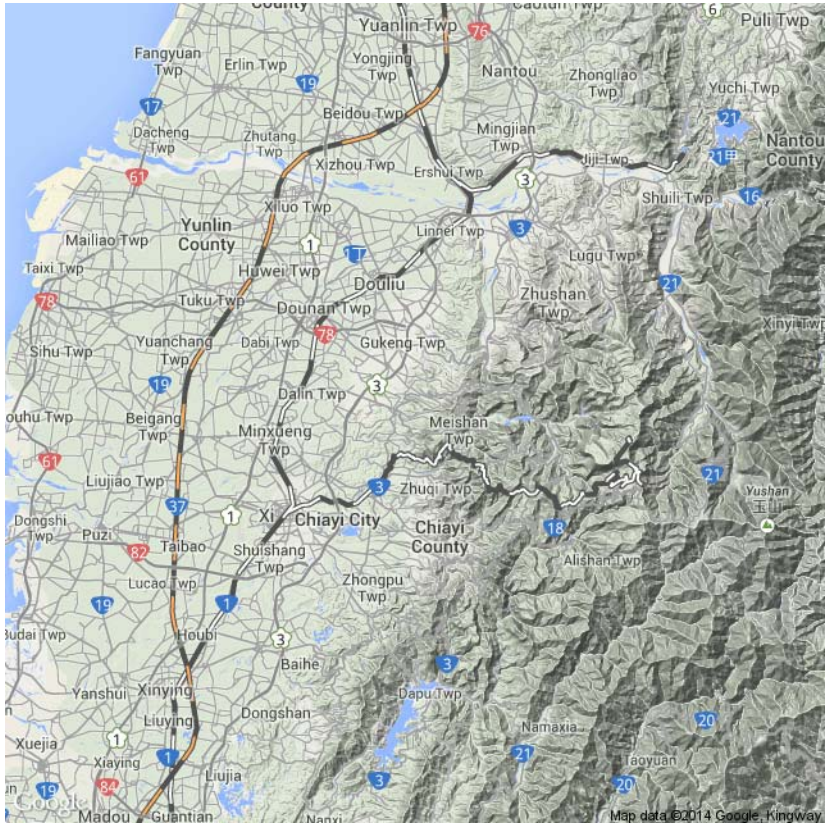
```
GetMap(center = c(lat = 42, lon = -76), size = c(640, 640), destfile,
    zoom = 12, markers, path = "", span, frame, hl, sensor = "true",
    maptype = c("roadmap", "mobile", "satellite", "terrain",
        "hybrid", "mapmaker-roadmap", "mapmaker-hybrid")[2],
    format = c("gif", "jpg", "jpg-baseline", "png8", "png32")[5],
    RETURNIMAGE = TRUE, GRAYSCALE = FALSE, NEWMAP = TRUE, SCALE = 1,
    verbose = 0)
```

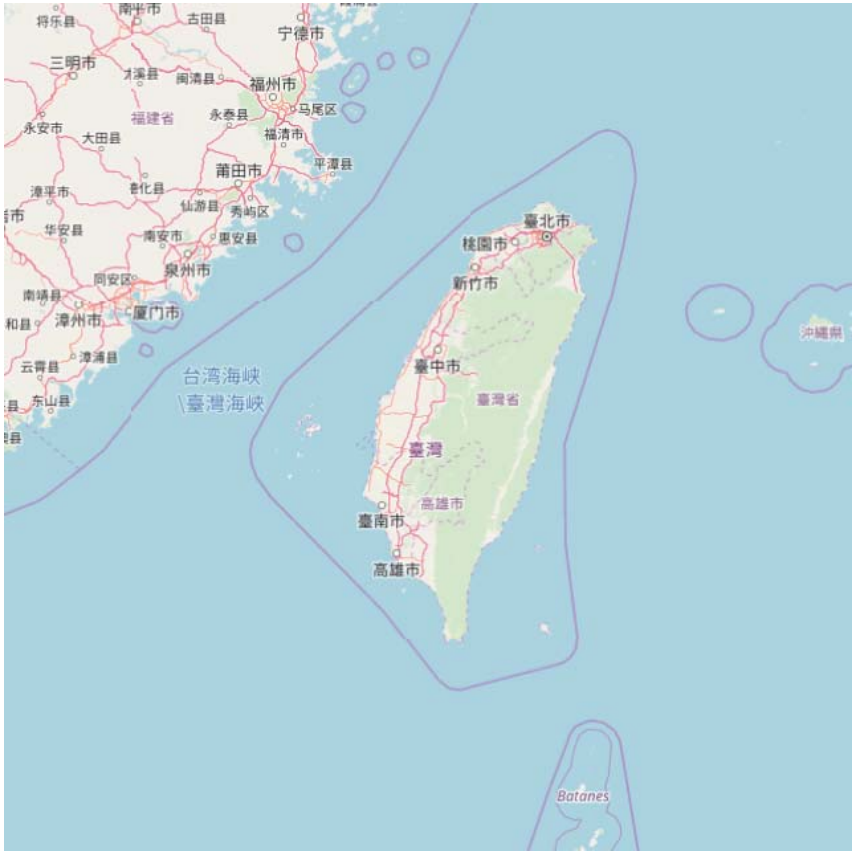

```
library(RgoogleMaps)
WorldMap <- GetMap(center=c(0,0), zoom =1,
                   destfile = "World1.png")
```


```
> library(ggmap)
> twmap <- get_map(location = 'Taiwan', zoom = 7, language = "zh-TW")
Error: Google now requires an API key.
       See ?register_google for details.
```

台灣地圖

```
TaiwanMap <- GetMap(center=c(lat = 23.58, lon =120.58), zoom =7, destfile = "Taiwan1.png")
TaiwanMap <- GetMap(center=c(lat = 23.58, lon =120.58), zoom = 10, destfile = "Taiwan2.png",
maptype = "terrain")
```




宁德市
三明市
福州市
马尾区
永安市
大田县
永泰县
福清市
福建省
莆田市
平潭县
漳平市
德化县
仙游县
秀屿区
华安县
南安市
惠安县
泉州市
同安区
南靖县
漳州市
厦门市
和县
云霄县
漳浦县
东山县
台湾海峡
\臺灣海峽
臺北市
桃園市
新竹市
臺中市
臺灣省
臺灣
高雄市
臺南市
高雄市
沖繩県
Batanes

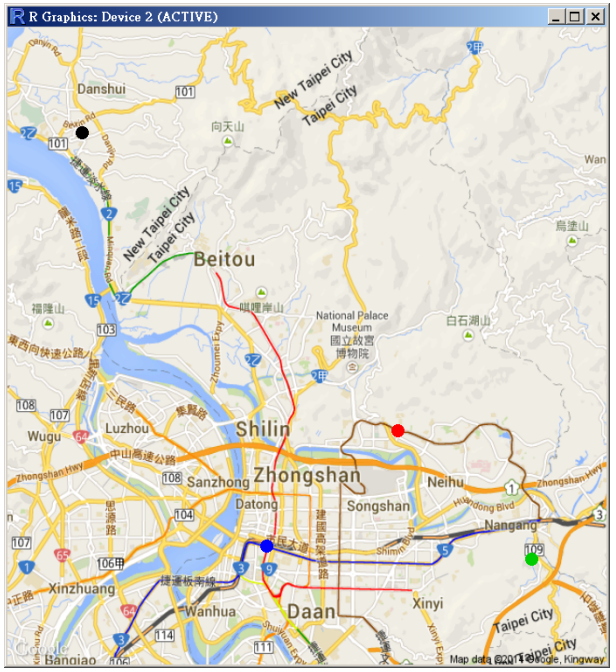

溪湖鎮
員林市
芳苑鄉
永靖鄉
二林鎮
南投市
社頭鄉
中寮鄉
北斗鎮
田中鎮
大城鄉
竹塘鄉
名間鄉
集集鎮
水里鄉
二水鄉
西螺鎮
二崙鄉
莿桐鄉
林內鄉
竹山鎮
鹿谷鄉
麥寮鄉
崙背鄉
臺西鄉
虎尾鎮
斗六市
褒忠鄉
東勢鄉
土庫鎮
斗南鎮
信義鄉
元長鄉
大埤鄉
古坑鄉
四湖鄉
溪口鄉
大林鎮
口湖鄉
北港鎮
梅山鄉
新港鄉
民雄鄉
竹崎鄉
六腳鄉
嘉義市
番路鄉
阿里山鄉
太保市
水上鄉
中埔鄉
鹿草鄉
後壁區
白河區
東山區
新營區
大埔鄉
柳營區
下營區
六甲區
官田區

於地圖上標記

```
> my.lat <- c(25.175339, 25.082288, 25.042185, 25.046254)
> my.lon <- c(121.450003, 121.565481, 121.614548, 121.517532)
> bb = qbbox(my.lat, my.lon)
> print(bb)
$latR
[1] 25.04152 25.17600

$lonR
[1] 121.4492 121.6154
> MyMap <- GetMap.bbox(bb$lonR, bb$latR, destfile = "my.png", maptype = "roadmap")
> My.markers <- cbind.data.frame(lat = my.lat, lon = my.lon)
> tmp <-  PlotOnStaticMap(MyMap, lat = My.markers[,"lat"], lon = My.markers[,"lon"], destfile
= "my.png", cex=2.5, pch=20, col=1:4, add=F)
```

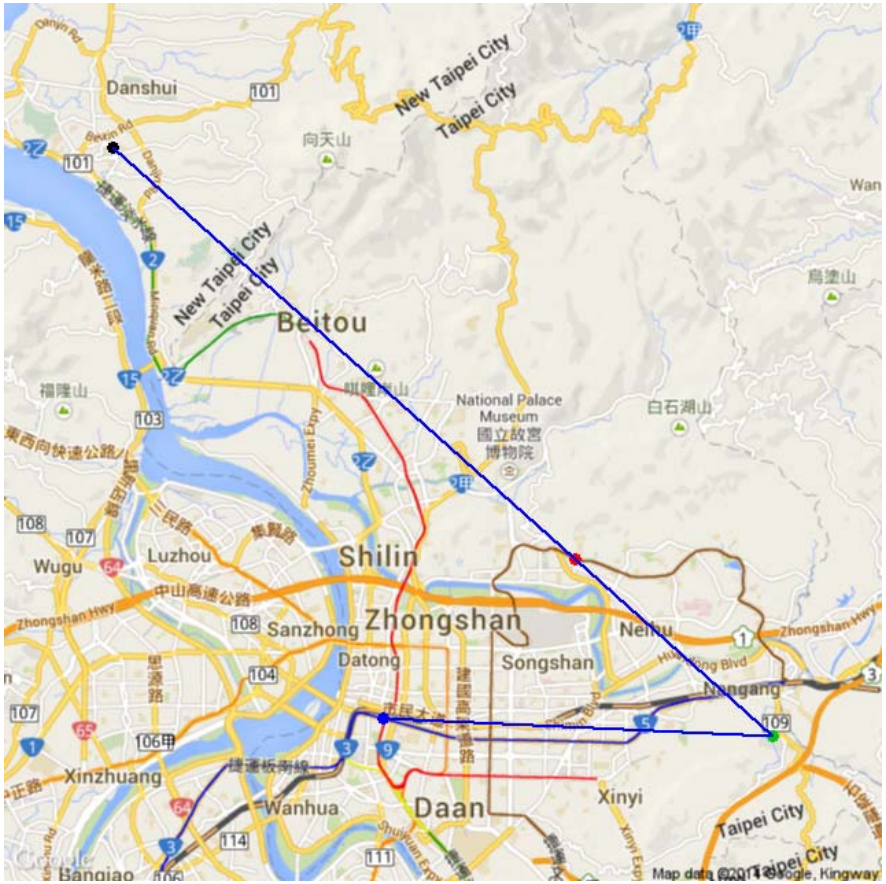
查詢經緯度
http://card.url.com.tw/realads/map_latlng.php

- 淡江大學 25.175339, 121.450003
- 台北市的地理中心位置: 內湖區環山路和內湖路一段跟基湖路口: 25.082288, 121.565481
- 中研院 25.042185, 121.614548
- 捷運台北站: 25.046254,121.517532



於地圖上標記

```
png("my2.png", 640, 640)
tmp <-  PlotOnStaticMap(MyMap, lat = My.markers[,"lat"], lon = My.markers[,"lon"], cex=2.5,
pch=20, col=1:4, add=F)
tmp <-  PlotOnStaticMap(MyMap, lat = My.markers[,"lat"], lon = My.markers[,"lon"], col="blue",
add=T, FUN = lines, lwd = 2)
dev.off()
```



於地圖上加文字，加圖片

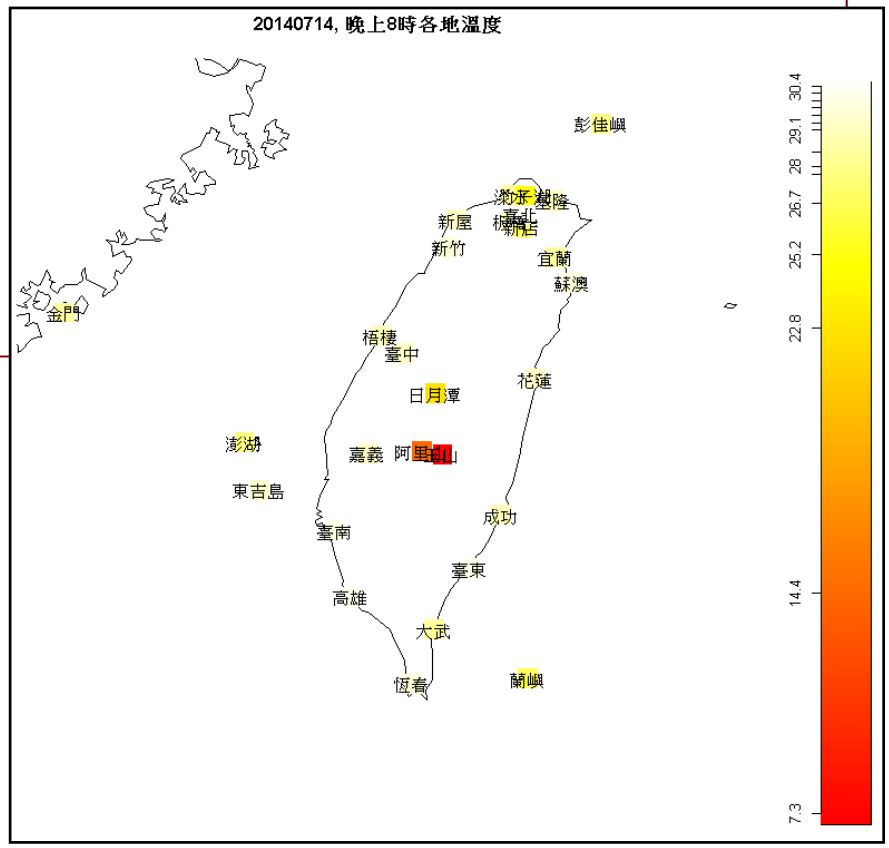
```
> library(RgoogleMaps)
> my.lat <- c(25.175339, 25.14362, 24.942605)
> my.lon <- c(121.450003, 121.501768, 121.368381)
>
> bb = qbbox(my.lat, my.lon)
> print(bb)
$latR
[1] 24.94144 25.17650

$lonR
[1] 121.3677 121.5024
> MyMap <- GetMap.bbox(bb$lonR, bb$latR,
+          destfile = "my.png", maptype = "roadmap")
>
> My.markers <- cbind.data.frame(lat = my.lat, lon = my.lon)
> tmp <- PlotOnStaticMap(MyMap, lat = My.markers[,"lat"],
+                                lon = My.markers[,"lon"],
+    destfile = "my.png", cex=2.5, pch=18:10, col=1:3, add=F)
> TextOnStaticMap(MyMap, lat = My.markers[,"lat"]+0.01,
+                        lon = My.markers[,"lon"],
+  labels=c("我家", "復興高中", "國立臺北大學三峽校區"),  add=T)
```


```
> library(EBImage)
> ntpu <- readImage("NTPUcolorlogo.jpg")
> loc <- LatLon2XY.centered(MyMap, lat=My.markers[3, 1], lon=My.markers[3, 2])
> rasterImage(ntpu, loc[[1]], loc[[2]]+30, loc[[1]]+50, loc[[2]]+80)
> Fuxing <- readImage("Fuxinglogo.jpg")
> loc <- LatLon2XY.centered(MyMap, lat=My.markers[2, 1], lon=My.markers[2, 2])
> rasterImage(Fuxing, loc[[1]], loc[[2]]+30, loc[[1]]+50, loc[[2]]+80)
```

Package: maps, mapdata

氣象局開放資料平台 http://opendata.cwb.gov.tw/

```
library(maps); library(maptools); library(mapdata); library(mapproj)
layout(matrix(c(1,1,1,0,2,0), ncol=2), widths=c(10, 1), heights=c(1, 10, 1))
map("world2Hires", xlim=c(118, 123), ylim=c(21, 26))
data <- read.table("20140714-weather.txt", sep="\t", header=TRUE, row.names=1)
x <- data$TEMP
tm <- floor((100-1)/(max(x)-min(x))*(x-min(x)) + 1)
used.col <- heat.colors(100)[tm]
points(data$lon, data$lat, pch=15, col=used.col)
text(data$lon, data$lat, labels=row.names(data))
title("20140714, 晚上8時各地溫度")
par(mar=c(1,1,1,1))
image(t(matrix(c(1:100), ncol=1)),
      col=heat.colors(100), xaxt="n", yaxt="n")
axis(LEFT <- 2, at=tm/100,
     labels=as.character(x), cex.axis=1)
```



See also:

Spatial data in R: Using R as a GIS

http://pakillo.github.io/R-GIS-tutorial/

ggmap: Spatial Visualization with ggplot2

ggmap quickstart

For more functionality, see ggmap documentation and https://dl.dropboxusercontent.com/u/24648660/ggmap%20useR%202012.pdf

There are 2 basic steps to making a map using ggmap:

Part 1: Download map raster → Part 2: Plot raster and overlay data

Part 1: Downloading the map raster

Start by loading the package: library(ggmap)

1. Define location: 3 ways

- location/address
  myLocation <- "University of Washington"
- lat/long
  myLocation <- c(lon = -95.3632715, lat = 29.7632836)
- bounding box lowerleftlon, lowerleftlat, upperrightlon, upperrightlat (a little glitchy for google maps)
  myLocation <- c(-130, 30, -105, 50)

Convert location/address its lat/long coordinates:
geocode("University of Washington")

2. Define map source, type, and color

The get_map function provides a general approach for quickly obtaining maps from multiple sources. I like this option for exploring different styles of maps.

There are 4 map "sources" to obtain a map raster, and each of these sources has multiple "map types" (displayed on right).

- stamen: maptype = c("terrain", "toner", "watercolor")
- google: maptype = c("roadmap", "terrain", "satellite", "hybrid")
- osm: open street map
- cloudmade: 1000s of maps, but an api key must be obtained from http://cloudmade.com

```
myMap <- get_map(location=myLocation,
source="stamen", maptype="watercolor", crop=FALSE)
ggmap(myMap)
```

This will produce a map that looks something like this

NOTE: crop = FALSE because otherwise, with stamen plots, the map is slightly shifted when I overlay data.

3. Fine tune the scale of the map using zoom

The get_map function takes a guess at the zoom level, but you can alter it:

zoom = integer from 3-21

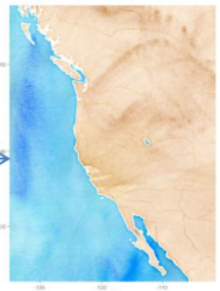
3 = continent, 10=city, 21=building

(openstreetmap limit of 18)

The following maps show different map source/type options (except cloudmade)

The appearance of these maps may be very different depending on zoom/scale

stamen: watercolor



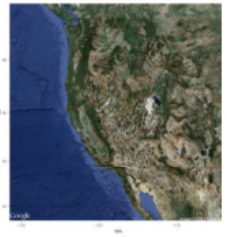
stamen: toner

stamen: terrain

If you can't get the map you want by adjusting the location/zoom variables, the functions designed for the different map sources provide more options:
get_googlemap,
get_openstreetmap,
get_stamenmap,
get_cloudmademap

google: terrain

google: satellite



google: roadmap

google: hybrid

osm*

*Open street maps may return a '503 Service Unavailable' error. This means their server is unavailable, and you must wait for it to become available again.

All maps can be displayed in black and white
color = "bw"

myMap <-
get_map(location=myLocation,
source="osm", color="bw"))

- If you use Rstudio: Sometimes a plot will not display. Increasing the size of the plot window may help. dev.off() prior to plotting may also help.
- The urlonly = TRUE will return a url that will display your map in a web browser. Which is pretty cool and may be handy!
- legend="topleft" will inset the legend on the top left of the map is data is overlayed (page 2).

ggmap: Spatial Visualization with ggplot2

ggmap quickstart

Part 2: Plotting the maps and data

1. Plot the raster:

```
ggmap(myMap)
```

2. Add points with latitude/longitude coordinates:

```
ggmap(myMap)+
geom_point(aes(x = Longitude, y = Latitude), data = data,
        alpha = .5, color="darkred", size = 3)
```

alpha = transparency
color = color
size = size of points

The size, color, alpha, and shape of the points can be scaled relative to another variable (in this case estArea) within the aes function:

```
ggmap(myMap)+
geom_point(aes(x = Longitude, y = Latitude, size=sqrt(estArea)),
data = data, alpha = .5, color="darkred")
```

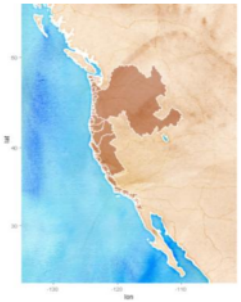
Additional functions can be added to control scaling, e.g.:

```
ggmap(myMap)+
  geom_point(aes(x = Longitude, y = Latitude, size=sqrt(estArea)),
  data = data, alpha = .5, color="darkred")+
  scale_size(range=c(3,20))
```

3. Add polygons from shp file

The shp file is imported into R using the rgdal package, and must be transformed to geographic coordinates (latitude/longitude) on the World Geodetic System of 1984 (WGS84) datum using the rgdal package:

```
library(rgdal)
shpData <- readOGR(dsn="C:\\Documents and Settings\\Watershed", layer="WS")
proj4string(shpData)    # describes data's current coordinate reference system
# to change to correct projection:
shpData <- spTransform(shpData,
CRS("+proj=longlat +datum=WGS84"))
```



To plot the data:

```
geom_polygon(aes(x = long, y = lat, group=id),
data = shpData, color ="white", fill ="orangered4",
alpha = .4, size = .2)
```

color= outline color alpha = transparency
fill = polygon color size = outline size

4. Annotate figure

```
baylor <- get_map('baylor university', zoom = 15, maptype = 'satellite')
ggmap(baylor) +
 annotate('rect', xmin=-97.11, ymin=31.54, xmax=-97.12, ymax=31.55, col="red", fill="white")+
 annotate('text', x=-97.12, y=31.54, label = 'Statistical Sciences', colour = I('red'), size = 8)+
 annotate('segment', x=-97.12, xend=-97.12, y=31.55, yend=31.55,
       colour=I('red'), arrow = arrow(length=unit(0.3,"cm")), size = 1.5) +
 labs(x = 'Longitude', y = 'Latitude') + ggtitle('Baylor University')
```

Controlling size and color

size
- scale_size(range = c(3, 20))
- But, the following is better for display because it is based on area (rather than radius)
- scale_area(range=c(3,20))

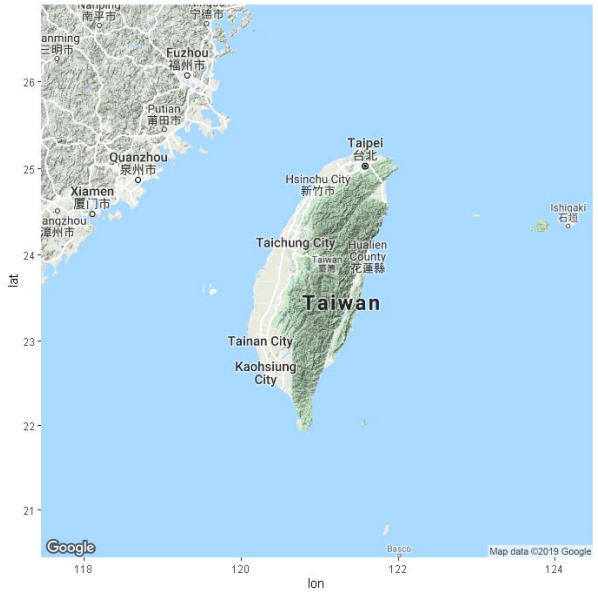
color
- Continuous variables: color gradient between n colors, e.g.:
- scale_colour_gradientn(colours = rainbow_hcl(7))
- Discrete variables, e.g.:
- scale_colour_manual(values=rainbow_hcl(7))
- scale_colour_manual(values=c("8" = "red", "4" = "blue","6" = "green")
- *Use colorspace and RColorBrewer to choose color combinations

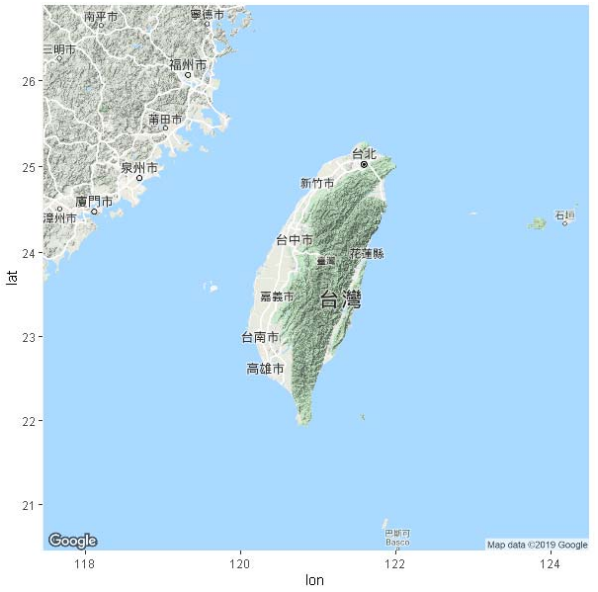
Page 2 ggmap, Melanie Frazier

ggmap: Spatial Visualization with ggplot2

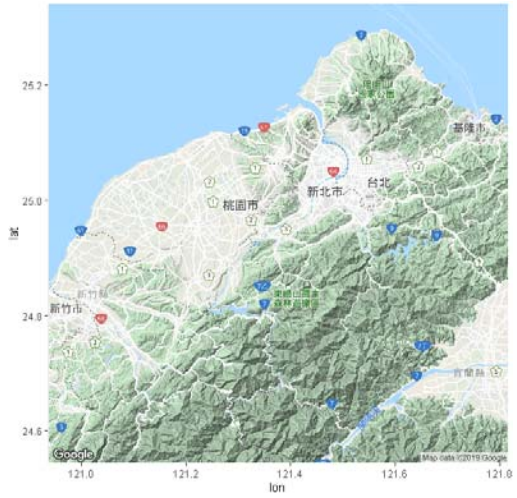
ggmap: A collection of functions to visualize spatial data and models on top of static maps from various online sources (e.g Google Maps and Stamen Maps). It includes tools common to those tasks, including functions for geolocation and routing.

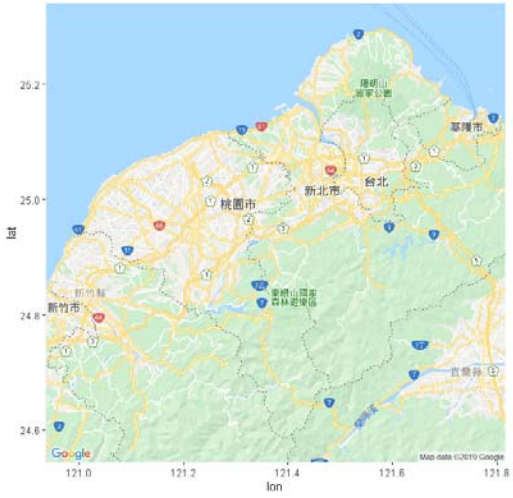
```
> library(ggmap)
> library(mapproj)
> tw.map <- get_map(location = 'Taiwan', zoom = 7)
Source :
https://maps.googleapis.com/maps/api/staticmap?center=Taiwan&zoom=7&size=640x640&scale=2&map
type=terrain&language=en-EN&key=AIzaSyCuYcvrytmKLGN
Source :
https://maps.googleapis.com/maps/api/geocode/json?address=Taiwan&key=AIzaSyCuYcvrytmKLGN
> ggmap(tw.map)
> tw.map.zh <- get_map(location = 'Taiwan', zoom = 7, language = "zh-TW")
> ggmap(tw.map.zh)
```





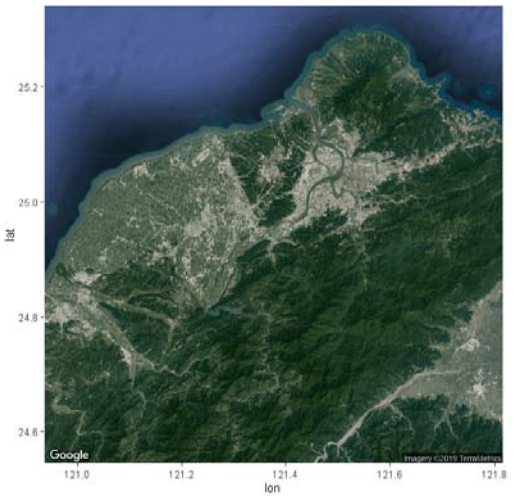
```
> tw.map.ntpu <- get_map(location = c(lon = 121.374925, lat = 24.943403),
                         zoom = 10, language = "zh-TW" , maptype = "terrain")
> ggmap(tw.map.ntpu)
```

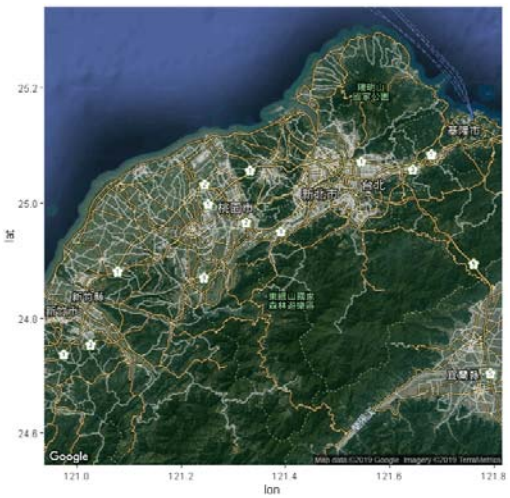


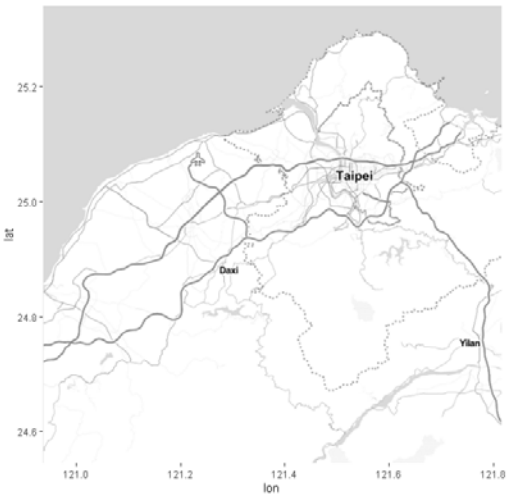



```
roadmap
satellite
hybrid
toner-lite
```

國立臺北大學三峽校區.
新北市三峽區大學路151號.
經緯度：(121.374925,24.943403)





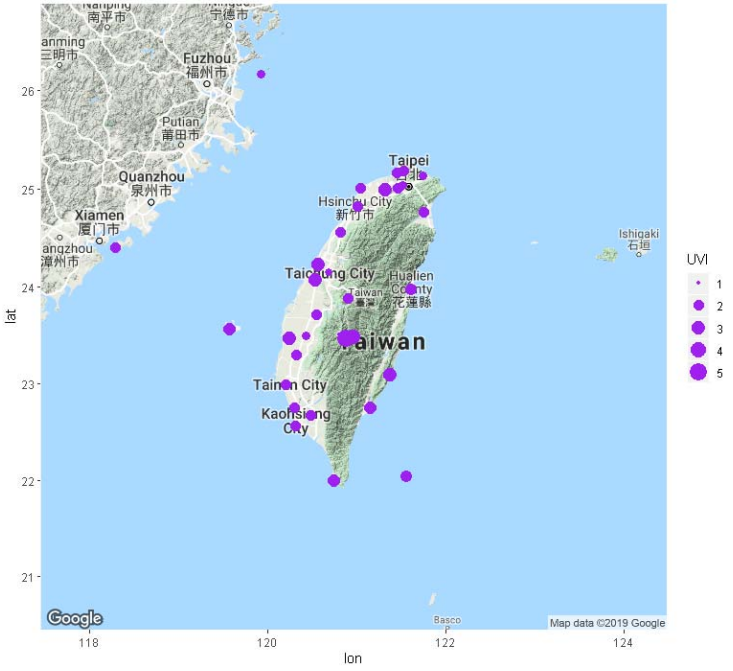


```
uv <- read.csv("UV_20151116152215.csv")
head(uv)

# 經緯度(度分秒) => 度數
lon.deg <- sapply((strsplit(as.character(uv$WGS84Lon), ",")), as.numeric)
lon.deg
uv$lon <- lon.deg[1, ] + lon.deg[2, ]/60 + lon.deg[3, ]/3600
lat.deg <- sapply((strsplit(as.character(uv$WGS84Lat), ",")), as.numeric)
uv$lat <- lat.deg[1, ] + lat.deg[2, ]/60 + lat.deg[3, ]/3600

tw.map <- get_map(location = 'Taiwan', zoom = 7)
ggmap(tw.map) +
  geom_point(data = uv, aes(x = lon, y = lat, size = UVI), color="purple")
```

https://data.gov.tw/dataset/6076

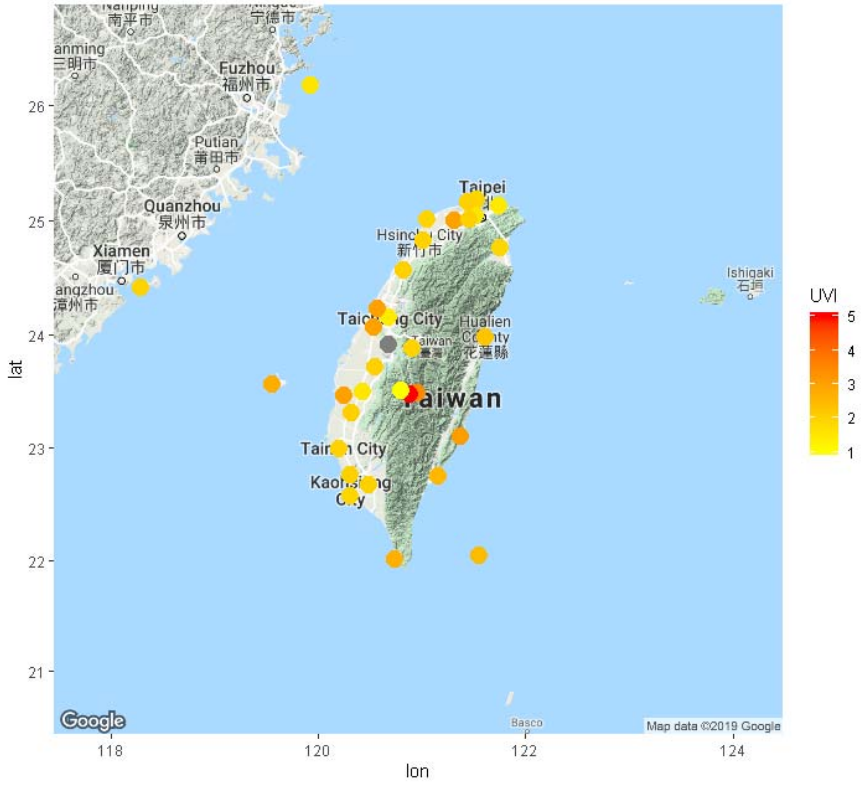
```
> head(uv)
  SiteName  UVI PublishAgency County  WGS84Lon WGS84Lat      PublishTime
1     花蓮 2.27    中央氣象局 花蓮縣 121,36,48 23,58,30 2015-11-16 15:00
2     馬祖 1.58    中央氣象局 連江縣 119,55,24 26,10,09 2015-11-16 15:00
3     高雄 1.91    中央氣象局 高雄市 120,18,57 22,33,58 2015-11-16 15:00
4     玉山 3.49    中央氣象局 南投縣 120,57,34 23,29,15 2015-11-16 15:00
5     臺南 1.99    中央氣象局 臺南市 120,12,17 22,59,36 2015-11-16 15:00
6     新竹 1.94    中央氣象局 新竹縣 121,00,51 24,49,40 2015-11-16 15:00
```

```
> lon.deg
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
[1,]  121  119  120  120  120  121  121  120  121   121   121   121   121
[2,]   36   55   18   57   12    0   31   44   30    22    44     2    33
[3,]   48   24   57   34   17   51   47   47   53    24    26    51    30
     [,14] [,15] [,16] [,17] [,18] [,19] [,20]  [,21]  [,22] [,23]  [,24]
[1,]   121   120   118   121   119   120   120 120.00 120.00 120.0 120.00
[2,]     9    54    17    45    33    41    25  29.00  18.00  19.0  14.00
[3,]    17    29    21    24    47     3    58  16.92  20.48   2.1  50.46
      [,25]  [,26]  [,27]  [,28]  [,29]  [,30]  [,31] [,32]  [,33] [,34]
[1,] 120.00 120.00 120.00 120.00 120.00 120.00 121.00 121.0 121.00 120.0
[2,]  52.00  48.00  32.00  32.00  34.00  49.00  19.00  27.0  26.00  41.0
[3,]  50.06   5.02  41.98  29.47   7.66  12.72  11.87  31.2  57.26   7.1
```



參考: https://blog.gtwang.org/r/r-ggmap-package-spatial-data-visualization/2/

```
ggmap(tw.map) +
  geom_point(data = uv, aes(x = lon, y = lat, size = 2, color = UVI)) +
  scale_color_continuous(low = "yellow", high = "red") +
  guides(size = FALSE)
```

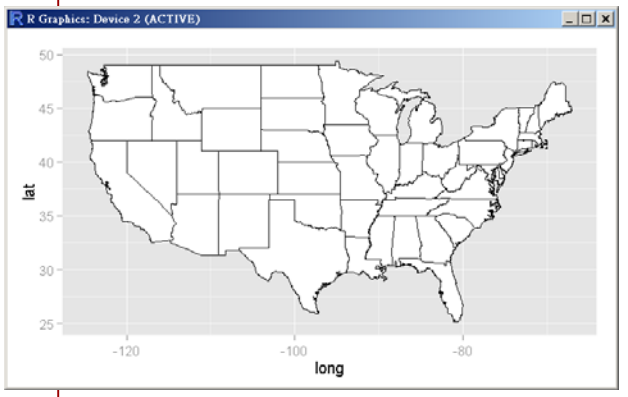


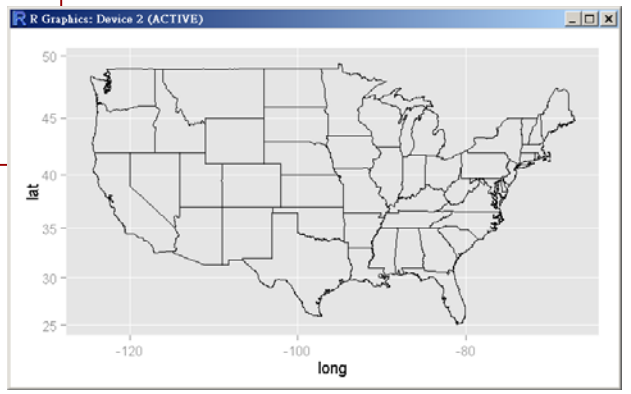
讀取中文檔問題:

```
Sys.setlocale(category = "LC_ALL", locale = "zh_TW.big5")
```

Creating a Map

```
> library(ggplot2)
> library(maps)
> library(mapproj)
> states.map <- map_data("state")
> head(states.map, 3)
       long      lat group order  region subregion
1 -87.46201 30.38968     1     1 alabama      <NA>
2 -87.48493 30.37249     1     2 alabama      <NA>
3 -87.52503 30.37249     1     3 alabama      <NA>
> tail(states.map, 3)
           long      lat group order  region subregion
15597 -107.9223 41.01805    63 15597 wyoming      <NA>
15598 -109.0568 40.98940    63 15598 wyoming      <NA>
15599 -109.0511 40.99513    63 15599 wyoming      <NA>

> ggplot(states.map, aes(x=long, y=lat, group=group)) +
    geom_polygon(fill="white", colour="black")

> ggplot(states.map, aes(x=long, y=lat, group=group)) +
    geom_path() + coord_map("mercator")
```



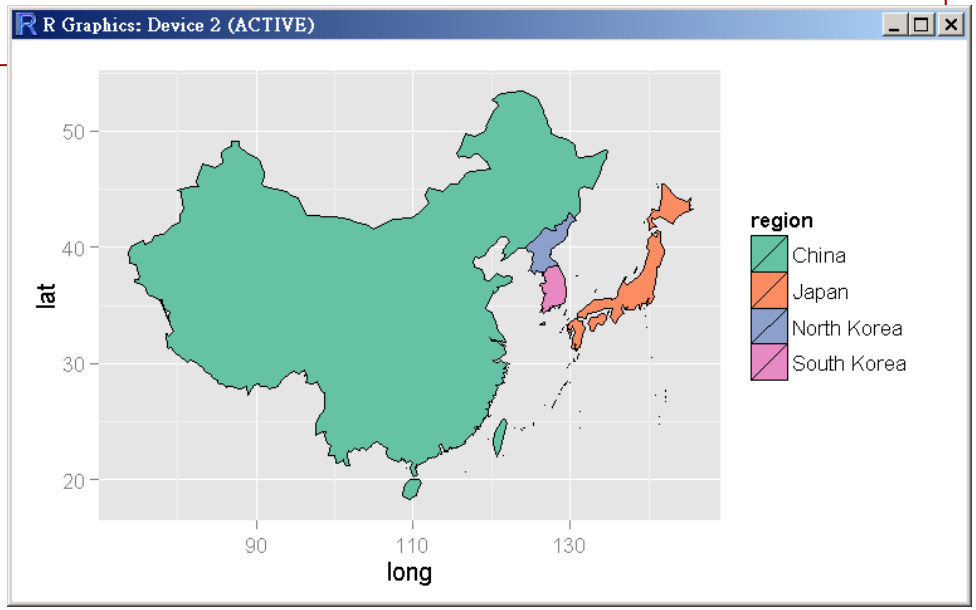


mercator: equally spaced straight meridians, conformal, straight compass courses

Source: 13.17. Creating a Map, R Graphics Cookbook 2nd

Creating a Map

```
> # map_data: county, france, italy, nz, state, usa, world, world2.
> # region names
> world.map <- map_data("world")
> sort(unique(world.map$region))
  [1] "Afghanistan"                "Albania"
  [3] "Algeria"                    "American Samoa"
  [5] "Andaman Islands"            "Andorra"
   ...
> east.asia <- map_data("world", region=c("Japan", "China", "North Korea",
"South Korea"))
> ggplot(east.asia, aes(x=long, y=lat, group=group, fill=region)) +
    geom_polygon(colour="black") +
    scale_fill_brewer(palette="Set2")
```



NOTE:

See the **mapdata** package for more map data sets. It includes maps of China and Japan, as well as a high-resolution world map, **worldHires**.

See Also: **mapproject, map**

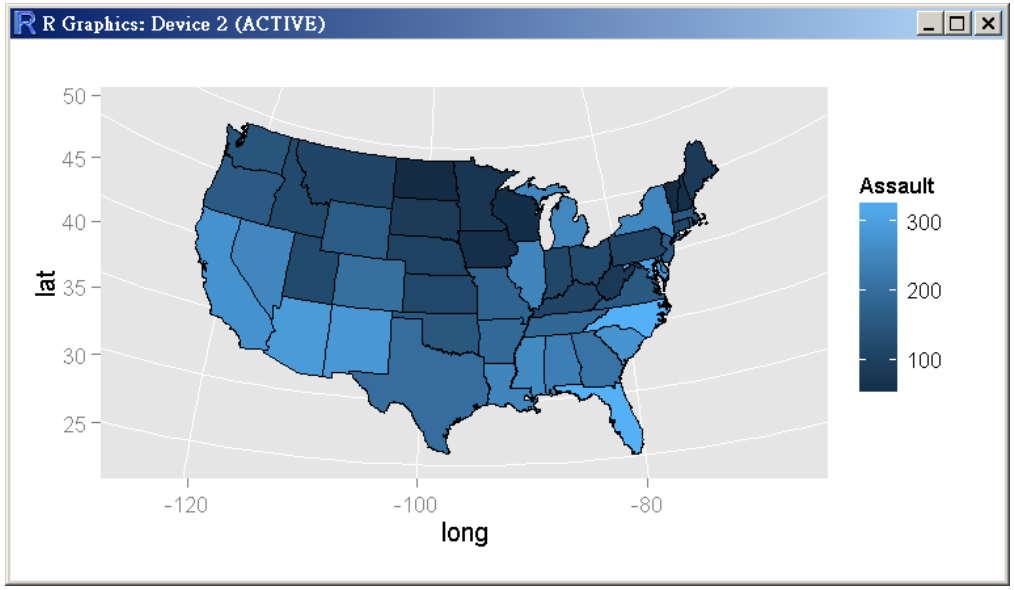
分級著色圖 (Choropleth Maps)

Violent Crime Rates by US State (USArrests): the data set contains statistics, in arrests per 100,000 residents for assault, murder, and rape in each of the 50 US states in 1973. Also given is the percent of the population living in urban areas.

```
> head(USArrests, 3)
           Murder Assault UrbanPop Rape
Alabama      13.2     236       58 21.2
Alaska       10.0     263       48 44.5
Arizona       8.1     294       80 31.0
> crimes <- data.frame(state = tolower(rownames(USArrests)), USArrests)
> head(crimes, 3)
               state Murder Assault UrbanPop Rape
Alabama      alabama   13.2     236       58 21.2
Alaska        alaska   10.0     263       48 44.5
Arizona      arizona    8.1     294       80 31.0

> library(maps); library(ggmap)
> states.map <- map_data("state")
> head(states.map, 3)
       long      lat group order  region subregion
1 -87.46201 30.38968     1     1 alabama      <NA>
2 -87.48493 30.37249     1     2 alabama      <NA>
3 -87.52503 30.37249     1     3 alabama      <NA>
> crime.map <- merge(states.map, crimes, by.x="region", by.y="state")
> head(crime.map, 3)
   region      long      lat group order subregion Murder Assault UrbanPop Rape
1 alabama -87.46201 30.38968     1     1      <NA>   13.2     236       58 21.2
2 alabama -87.48493 30.37249     1     2      <NA>   13.2     236       58 21.2
3 alabama -87.95475 30.24644     1    13      <NA>   13.2     236       58 21.2
```

分級著色圖 (Choropleth Maps)

```
> # After merging, the order has changed, which would lead to polygons drawn in
> # the incorrect order. So, we sort the data.
> library(plyr) # For arrange() function
> # Sort by group, then order
> crime.map <- arrange(crime.map, group, order)
> head(crime.map, 3)
   region      long      lat group order subregion Murder Assault UrbanPop Rape
1 alabama -87.46201 30.38968     1     1      <NA>   13.2     236       58 21.2
2 alabama -87.48493 30.37249     1     2      <NA>   13.2     236       58 21.2
3 alabama -87.52503 30.37249     1     3      <NA>   13.2     236       58 21.2
> ggplot(crime.map, aes(x=long, y=lat, group=group, fill=Assault)) +
         geom_polygon(colour="black") +
         coord_map("polyconic")
```



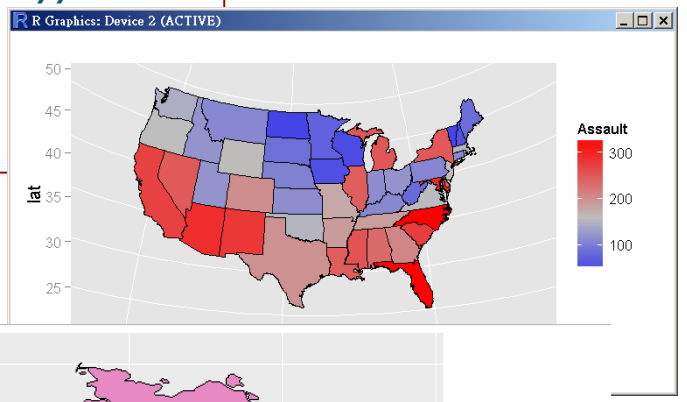
NOTE:

choroplethr: Simplify the Creation of Choropleth Maps in R

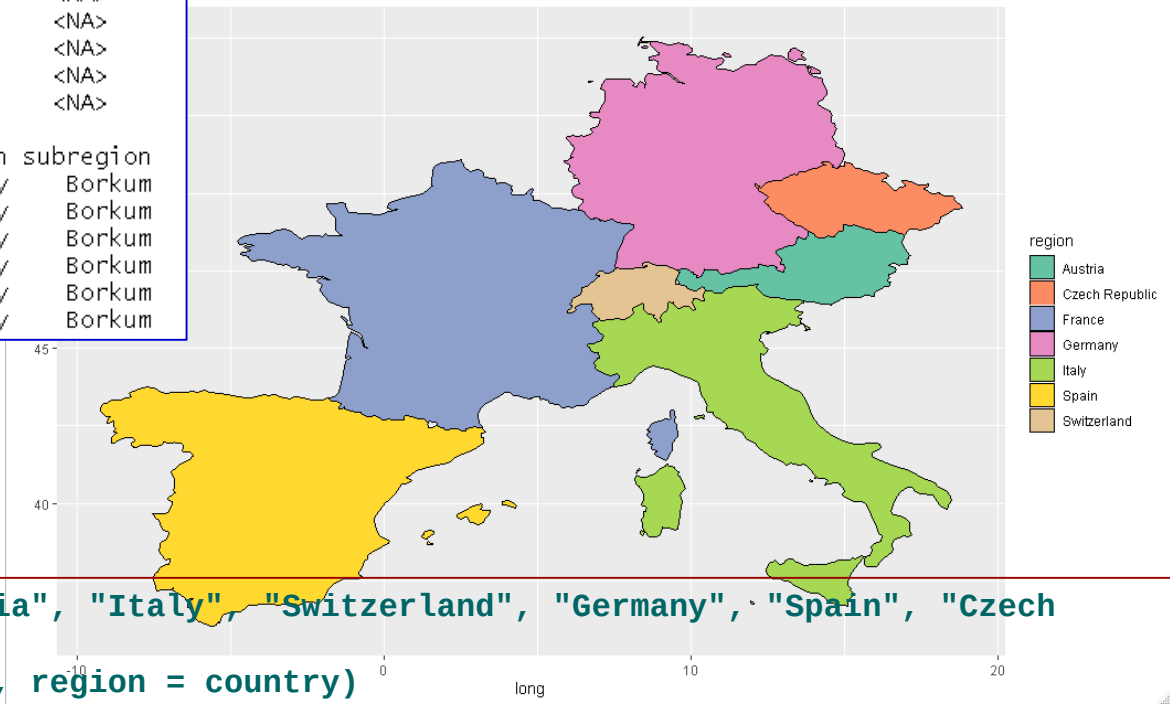
choroplethrMaps: Contains Maps Used by the 'choroplethr' Package Contains 3 maps: US States, US Counties, Countries of the world.

分級著色圖 (Choropleth Maps)

```
ggplot(crime.map, aes(x=long, y=lat, group=group, fill=Assault)) +
    geom_polygon(colour="black") +
    coord_map("polyconic") +
    scale_fill_gradient2(low="blue", mid="grey", high="red",
                         midpoint=median(crimes$Assault))
```




```
> head(mymapdata)
      long      lat group order  region subregion
1 16.95312 48.59883     1     1 Austria      <NA>
2 16.94883 48.58858     1     2 Austria      <NA>
3 16.94336 48.55093     1     3 Austria      <NA>
4 16.90449 48.50352     1     4 Austria      <NA>
5 16.86270 48.44141     1     5 Austria      <NA>
6 16.86543 48.38691     1     6 Austria      <NA>
> tail(mymapdata)
         long      lat group order  region subregion
2941 6.734766 53.58252    26  2941 Germany    Borkum
2942 6.642090 53.57920    26  2942 Germany    Borkum
2943 6.668555 53.60566    26  2943 Germany    Borkum
2944 6.754590 53.62549    26  2944 Germany    Borkum
2945 6.800879 53.62549    26  2945 Germany    Borkum
2946 6.734766 53.58252    26  2946 Germany    Borkum
```

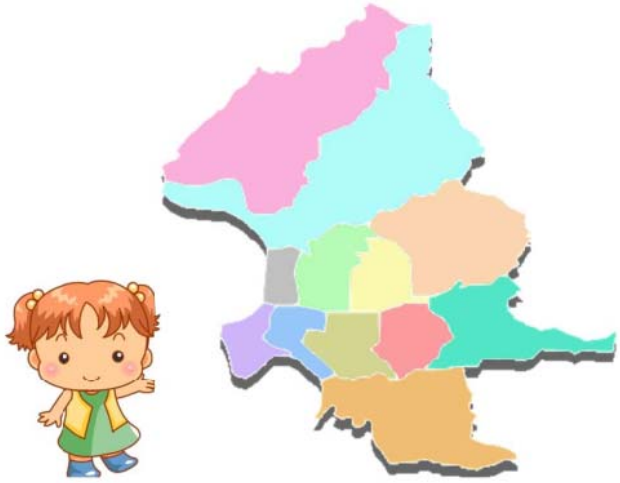



```
> country <- c("France", "Austria", "Italy", "Switzerland", "Germany", "Spain", "Czech
Republic")
> mymapdata <- map_data("world", region = country)
> ggplot(mymapdata, aes(x = long, y = lat, group = group, fill = region)) +
   geom_polygon(colour = "black") +
   scale_fill_brewer(palette = "Set2")
```

美麗臺北 Beautiful Taipei
TAIPEI
花園 生態 友善 環保

臺北市各行政區
重要統計指標

中華民國 107 年



臺北市政府主計處編印

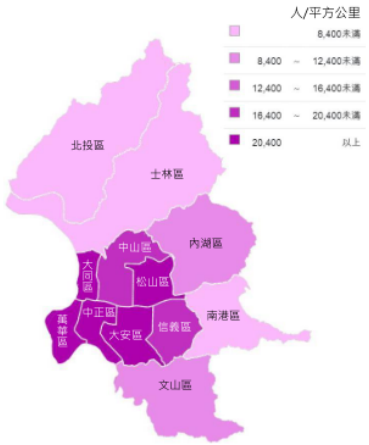
中華民國 108 年 6 月出版

3.人口概況

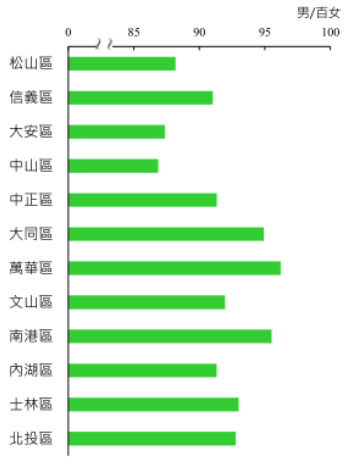
臺北市 107 年底戶籍登記人口密度以大安區最高，北投區最低；性比例則以萬華區最高，中山區最低，皆為女性多於男性。

人 口 概 況
107 年底

人口密度



性比例



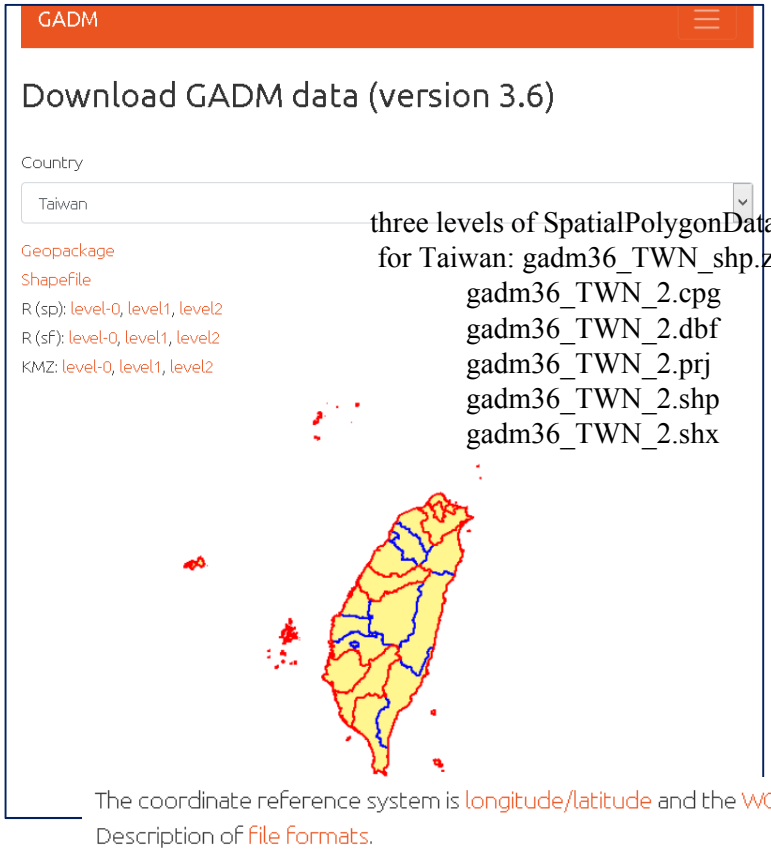
項目	人口數			戶數	戶量	人口密度	性比例
		男	女				
單位	人	人	人	戶	人/戶	人/平方公里	男/百女
107年底	2,668,572	1,273,375	1,395,197	1,056,233	2.53	9,818	91.27
松山區	205,702	96,393	109,309	81,128	2.54	22,148	88.18
信義區	223,406	106,457	116,949	89,574	2.49	19,933	91.03
大安區	高308,843	高144,007	高164,836	高121,344	2.55	高27,184	87.36
中山區	229,456	106,664	122,792	100,494	低2.28	16,771	低86.87
中正區	159,000	75,898	83,102	65,474	2.43	20,902	91.33
大同區	127,625	62,148	65,477	51,781	2.46	22,463	94.92
萬華區	189,603	92,969	96,634	78,770	2.41	21,419	高96.21
文山區	273,762	131,145	142,617	106,640	2.57	8,688	91.96
南港區	低121,670	低59,439	低62,231	低47,386	2.57	5,570	95.51
內湖區	287,429	137,196	150,233	108,739	2.64	9,102	91.32
士林區	286,544	138,079	148,465	107,521	高2.67	4,594	93.00
北投區	255,532	122,980	132,552	97,382	2.62	低4,497	92.78
計算方式 分子	人口數	男性人口數	女性人口數	戶數	人口數	人口數	男性人口數 *100
計算方式 分母					戶數	土地面積	女性人口數
資料來源	本府民政局						

說明：人口資料係戶籍登記數。

Shape files

GADM.org is a spatial database of the location of the world's administrative areas (or adminstrative boundaries) for use in GIS and similar software. Administrative areas in this database are countries and lower level subdivisions.
https://gadm.org/download_country_v3.html

零時政府: 台灣行政區域圖(Country, Town, Village)
https://github.com/g0v/twgeojson/tree/master/json



three levels of SpatialPolygonDataFram for Taiwan: gadm36_TWN_shp.zip:
gadm36_TWN_2.cpg
gadm36_TWN_2.dbf
gadm36_TWN_2.prj
gadm36_TWN_2.shp
gadm36_TWN_2.shx

政府資料開放平台
鄉鎮市區界線(TWD97經緯度)
https://data.gov.tw/dataset/7441
直轄市、縣市界線(TWD97經緯度)
https://data.gov.tw/dataset/7442

地圖Shape資料:

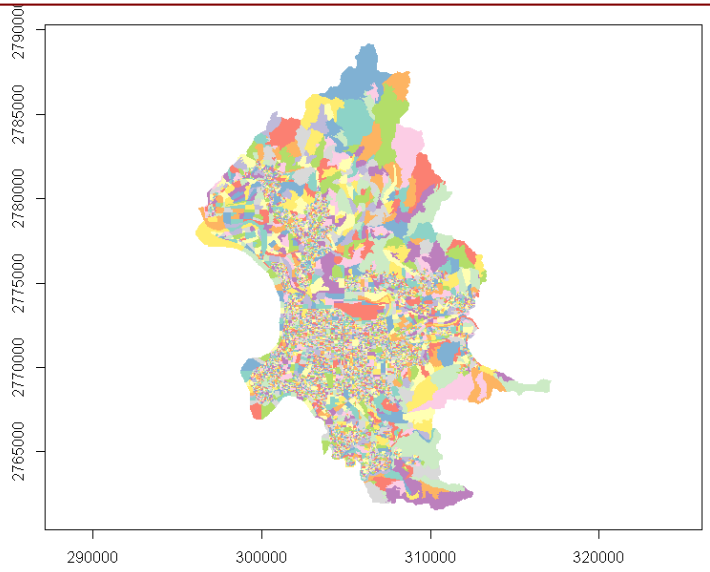
- shp: 用於儲存地圖元素的幾何資料。
- shx: 幾何資料索引，記錄每一shp檔案之中的位置。
- dbf: 以dBase IV的資料表格式儲存每個幾何形狀的屬性資料。
- prj (選項): shp檔中幾何資料使用的經緯度座標系統。

Shape files

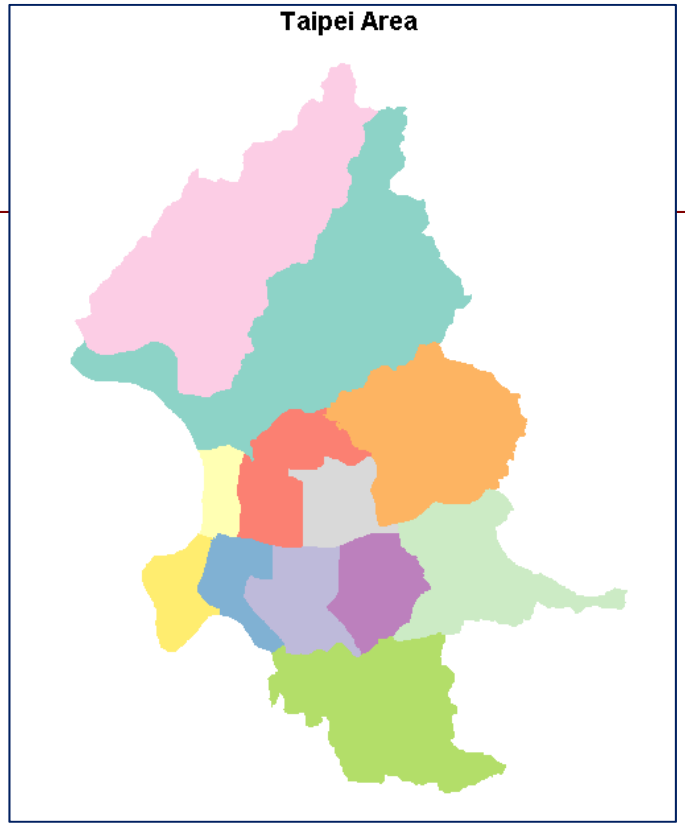
```
Sys.setlocale(category = "LC_ALL", locale = "cht")

Taipei <- st_read("Taipei.shp",
                  options = "ENCODING=UTF-8",
                  stringsAsFactors = FALSE)
head(Taipei)

Taipei$TOWN <- iconv(Taipei$TOWN, to="UTF-8")
Taipei$COUNTY <- iconv(Taipei$COUNTY, to="UTF-8")
head(Taipei)
dim(Taipei)
```


```
plot(st_geometry(Taipei),
     col = sf.colors(12, categorical = TRUE),
     border = "NA", #"transparent", #lightgray",
     axes = TRUE)
```

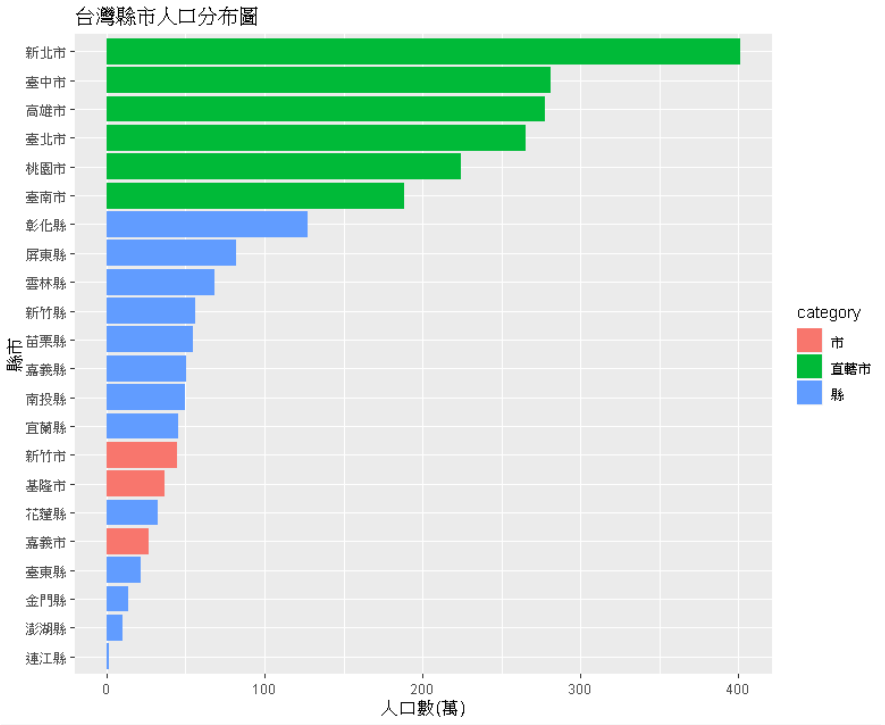
```
> head(Taipei)
Simple feature collection with 6 features and 11 fields
geometry type:  POLYGON
dimension:      XYZ
bbox:           xmin: 299986.2 ymin: 2775497 xmax: 311290.4 ymax: 2776375
epsg (SRID):    NA
proj4string:    +proj=tmerc +lat_0=0 +lon_0=121 +k=0.9999 +x_0=250000 +y_0=0 +ellps=GRS80 +unit
s=m +no_defs
  U_ID      CODEBASE        CODE1    CODE2  TOWN_ID   TOWN COUNTY_ID COUNTY        X       Y
1 1972 A6310-0024-00 A6310-01-006 A6310-01 63000100 內湖區     63000 臺北市 310920.8 2775936
2 1973 A6311-0791-00 A6311-61-005 A6311-61 63000110 士林區     63000 臺北市 300096.8 2776282
3 1974 A6311-0787-00 A6311-67-002 A6311-67 63000110 士林區     63000 臺北市 302742.4 2776312
4 1975 A6311-0793-00 A6311-62-004 A6311-62 63000110 士林區     63000 臺北市 302298.5 2776277
5 1976 A6311-0807-00 A6311-67-008 A6311-67 63000110 士林區     63000 臺北市 302811.7 2776207
6 1977 A6311-0792-00 A6311-67-003 A6311-67 63000110 士林區     63000 臺北市 302673.6 2776280
        AREA                          geometry
1 362112.907 POLYGON Z ((310568.7 277591...
2  17541.319 POLYGON Z ((299986.2 277633...
3   3627.653 POLYGON Z ((302752.2 277636...
4  15430.374 POLYGON Z ((302336.7 277636...
5  52775.400 POLYGON Z ((302717.4 277635...
6   5634.483 POLYGON Z ((302685.4 277634...
```



```
library(RColorBrewer)
#brewer.pal.info
nc <- length(unique(Taipei$TOWN)) # 12
brewer.pal(nc, "Set3")

plot(Taipei["AREA"],
     col = brewer.pal(nc, "Set3")[as.integer(as.factor(Taipei$TOWN))],
     border = "NA",
     key.pos = 1,
     breaks = my.breaks,
     key.width = lcm(2),
     axes = FALSE,
     main = "Taipei Area")
```



```
TW.Pop2019 <- read.csv("TW_Population2019.csv")
head(TW.Pop2019)
colnames(TW.Pop2019) <- c("rank", "city", "category", "population")
ggplot(TW.Pop2019, aes(x = reorder(city, population), y = population/10000,
                       fill = category)) +
  geom_bar(stat="identity") +
  coord_flip() +
  labs(title = "台灣縣市人口分布圖", x = "縣市", y = "人口數(萬)")
```



參考: How to plot a Taiwan Map colored with Population by ggplot2
http://www.rpubs.com/OzuShi/348822

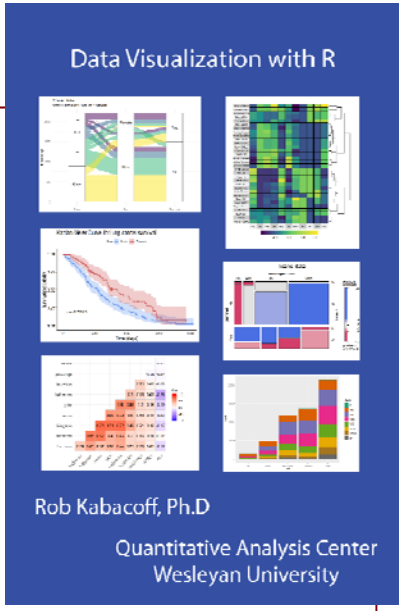
Dot Density Maps

```
> head(crime)
                   time     date hour premise           offense  beat     block    street type suffix number   month
82729 2010-01-01 14:00:00 1/1/2010    0     18A           murder 15E30 9600-9699   marlive   ln      -      1 january
82730 2010-01-01 14:00:00 1/1/2010    0     13R           robbery 13D10 4700-4799 telephone   rd      -      1 january
82731 2010-01-01 14:00:00 1/1/2010    0     20R aggravated assault 16E20 5000-5099  wickview   ln      -      1 january
82732 2010-01-01 14:00:00 1/1/2010    0     20R aggravated assault  2A30 1000-1099   ashland   st      -      1 january
82733 2010-01-01 14:00:00 1/1/2010    0     20A aggravated assault 14D20 8300-8399    canyon            -      1 january
82734 2010-01-01 14:00:00 1/1/2010    0     20R           burglary 18F60 9300-9399     rowan   ln      -      1 january
        day                  location           address       lon      lat
82729 friday    apartment parking lot   9650 marlive ln -95.43739 29.67790
82730 friday road / street / sidewalk 4750 telephone rd -95.29888 29.69171
82731 friday        residence / house  5050 wickview ln -95.45586 29.59922
82732 friday        residence / house   1050 ashland st -95.40334 29.79024
82733 friday                apartment       8350 canyon -95.37791 29.67063
82734 friday        residence / house     9350 rowan ln -95.54830 29.70223
```

```
> # install.packages("ggmap")
> library(ggmap)
> head(crime)
> dim(crime)
[1] 86314    17
```

The crime dataset from the **ggmap** package, contains the time, date, and location of six types of crimes in Houston, Texas between January 2010 and August 2010.

```
> summary(crime$offense)
aggravated assault  auto theft    burglary   murder  rape  robbery theft
              7177        7946       17802      157     378     6298    46556
>
> library(dplyr)
> rapes <- filter(crime, offense == "rape") %>%
+   select(date, offense, address, lon, lat)
> head(rapes)
      date offense             address       lon      lat
1 1/1/2010    rape   5950 glenmont dr -95.48498 29.72007
2 1/1/2010    rape    2350 sperber ln -95.34817 29.75505
...
6 1/2/2010    rape   1150 fidelity st -95.25535 29.74147
```

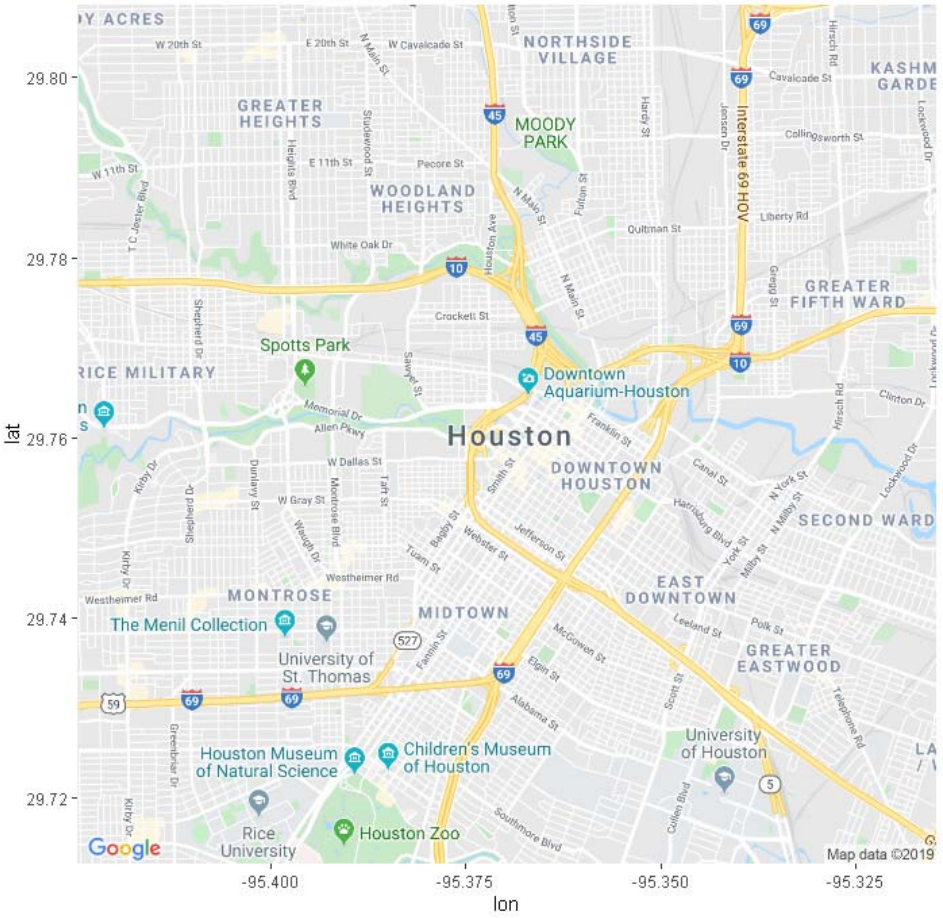


Get the background map image

```
> # (1) Find the center coordinates for Houston, TX
> houston_center <- geocode("Houston, TX")
Source :
https://maps.googleapis.com/maps/api/geocode/json?address=Houston,+TX&key=AIzaSyCuYcvrytmKLGN
> register_google(key = "AIzaSyCuYcvrytmKLGN1Z_y8Dh4WwFOeB6wnof8", write = TRUE)
Replacing old key (AIzaSyCuYcvrytmKLGN) with new key in C:/Users/userpc/Documents/.Renviron
> houston_center
# A tibble: 1 x 2
    lon   lat
  <dbl> <dbl>
1 -95.4  29.8
```

```
> has_google_key()
[1] TRUE
> google_key()
[1] "AIzaSyCuYcvrytmKLGN
```

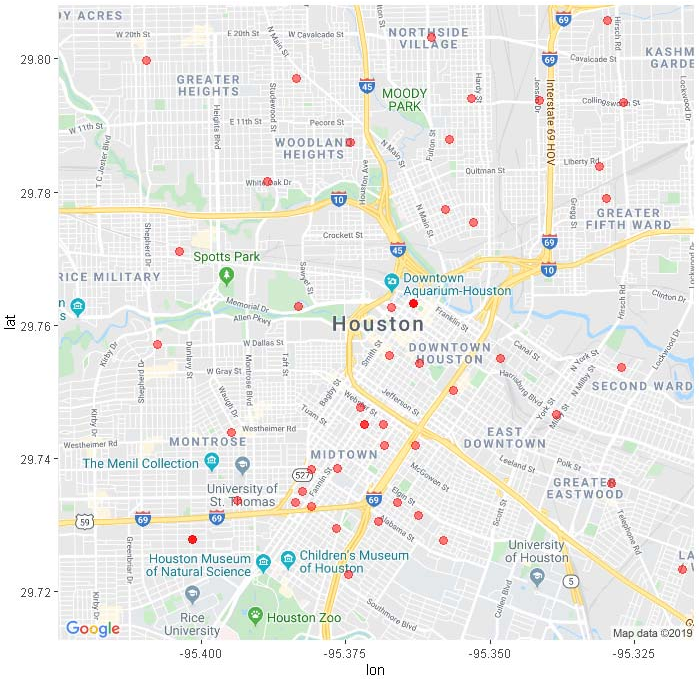
```
houston_map <- get_map(houston_center,
                       zoom = 13,
                       maptype = "roadmap")
ggmap(houston_map)
```

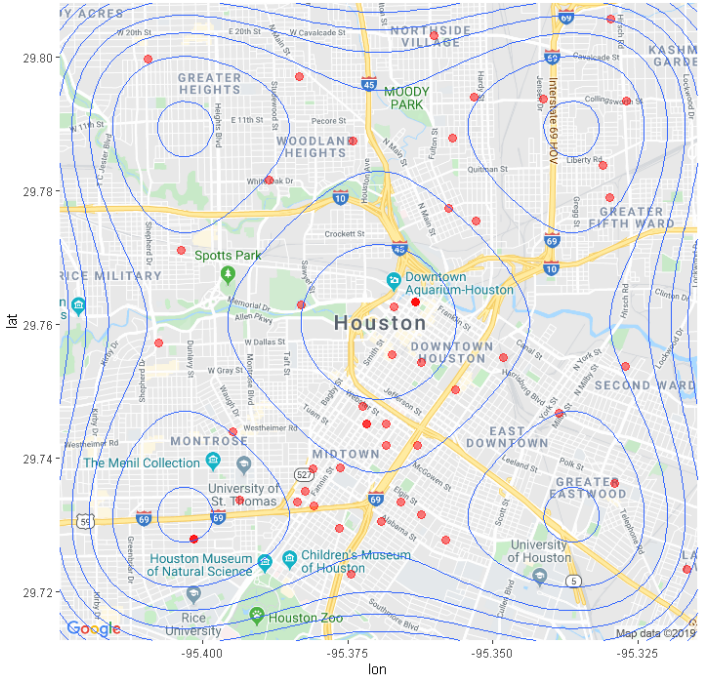


Add crime locations to the map

```
ggmap(houston_map,
      base_layer = ggplot(data = rapes, aes(x=lon, y = lat))) +
  geom_point(color = "red", size = 3, alpha = 0.5)
```

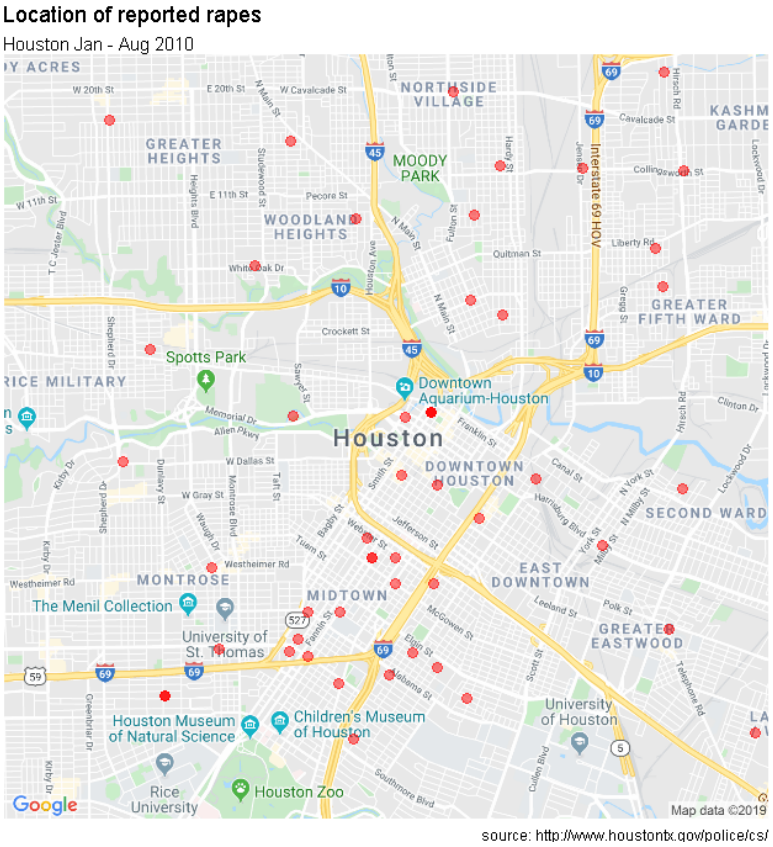
```
ggmap(houston_map) +
  geom_point(data = rapes, aes(x=lon, y = lat),
             color = "red", size = 3, alpha = 0.5) +
  geom_density2d(size = 0.3)
```





Remove long and lat numbers and add titles

```
ggmap(houston_map,
      base_layer = ggplot(data = rapes, aes(x=lon, y = lat))) +
  geom_point(color = "red", size = 3, alpha = 0.5) +
  theme_void() +
  labs(title = "Location of reported rapes",
       subtitle = "Houston Jan - Aug 2010",
       caption = "source: http://www.houstontx.gov/police/cs/")
```



NOTE:

`choroplethr`: Simplify the Creation of Choropleth Maps in R

`choroplethrMaps`: Contains Maps Used by the 'choroplethr' Package

Contains 3 maps: US States, US Counties, Countries of the world.

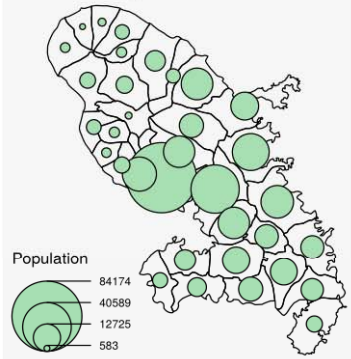
cartography: Thematic Cartography

https://cran.r-project.org/web/packages/cartography/vignettes/cartography.html

Thematic maps with cartography : : CHEAT SHEET

Use cartography with spatial objects from sf or sp packages to create thematic maps.

```
library(cartography)
library(sf)
mtq <- st_read("martinique.shp")
plot(st_geometry(mtq))
propSymbolsLayer(x = mtq, var = "P13_POP",
 legend.title.txt = "Population",
 col = "#a7dfb4")
```



Classification

Available methods are: quantile, equal, q6, fisher-jenks, mean-sd, sd, geometric progression...

```
bks1 <- getBreaks(v = var, nclass = 6,
 method = "quantile")
bks2 <- getBreaks(v = var, nclass = 6,
 method = "fisher-jenks")
pal <- carto.pal("green.pal",3, "wine.pal", 3)
hist(var, breaks = bks1, col = pal)
```


```
hist(var, breaks = bks2, col = pal)
```

Symbology

In most functions the x argument should be an sf object. sp objects are handled through spdf and df arguments.

Choropleth
```
choroLayer(x = mtq, var = "myvar",
 method = "quantile", nclass = 8)
```

Typology
```
typoLayer(x = mtq, var = "myvar")
```

Proportional Symbols
```
propSymbolsLayer(x = mtq, var = "myvar",
 inches = 0.1, symbols = "circle")
```

Colorized Proportional Symbols (relative data)
```
propSymbolsChoroLayer(x = mtq, var = "myvar",
 var2 = "myvar2")
```

Colorized Proportional Symbols (qualitative data)
```
propSymbolsTypoLayer(x = mtq, var = "myvar",
 var2 = "myvar2")
```

Double Proportional Symbols
```
propTrianglesLayer(x = mtq, var1 = "myvar",
 var2 = "myvar2")
```

OpenStreetMap Basemap (see rosm package)
```
tiles <- getTiles(x = mtq, type = "osm")
tilesLayer(tiles)
```

Isopleth (see SpatialPosition package)
```
smoothLayer(x = mtq, var = "myvar",
 typefct = "exponential", span = 500,
 beta = 2)
```

Discontinuities
```
discLayer(x = mtq.borders, df = mtq,
 var = "myvar", threshold = 0.5
```

Flows
```
propLinkLayer(x = mtq_link, df = mtq_df,
 var = "fij")
```

Dot Density
```
dotDensityLayer(x = mtq, var = "myvar")
```

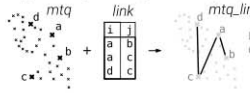
Labels
```
labelLayer(x = mtq, txt = "myvar",
 halo = TRUE, overlap = FALSE)
```

Transformations

Polygons to Grid
```
mtq_grid <- getGridLayer(x = mtq, cellsize = 3.6e+07,
  type = "hexagonal", var = "myvar")
```

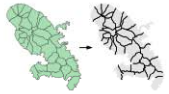
Grids layers can be used by choroLayer() or propSymbolsLayer().

Points to Links
```
mtq_link <- getLinkLayer(x = mtq, df = link)
```



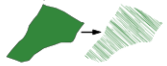
Links layers can be used by *LinkLayer().

Polygons to Borders
```
mtq_border <- getBorders(x = mtq)
```



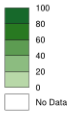
Borders layers can be used by discLayer() function

Polygons to Pencil Lines
```
mtq_pen <- getPencilLayer(x = mtq)
```



Legends

legendChoro()
```
legendChoro(pos = "topleft",
 title.txt = "legendChoro()",
 breaks = c(0,20,40,60,80,100),
 col = carto.pal("green.pal", 5),
 nodata = TRUE, nodata.txt = "No Data")
```



legendTypo()
```
legendTypo(title.txt = "legendTypo()",
 col = c("peru", "skyblue", "gray77"),
 categ = c("type 1", "type 2", "type 3"),
 nodata = FALSE)
```

legendCirclesSymbols()
```
legendCirclesSymbols(var = c(10,100),
 title.txt = "legendCirclesSymbols()",
 col = "#a7dfb4ff", inches = 0.3)
```

See also legendSquaresSymbols(), legendBarsSymbols(), legendGradLines(), legendPropLines() and legendPropTriangles().

Map Layout

North Arrow:
```
north(pos = "topright")
```

Scale Bar:
```
barscale(size = 5)
```

Full Layout:
```
layoutLayer(
 title = "Martinique",
 tabtitle = TRUE,
 frame = TRUE,
 author = "Author",
 sources = "Sources",
 north = TRUE,
 scale = 5)
```

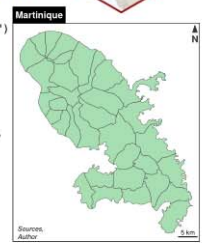
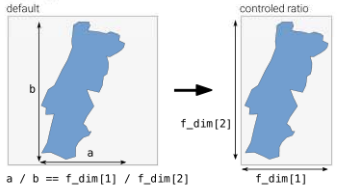


Figure Dimensions

Get figure dimensions based on the dimension ratio of a spatial object, figure margins and output resolution.

```
f_dim <- getFigDim(x = sf_obj, width = 500,
  mar = c(0,0,0,0))
png("fig.png", width = 500, height = f_dim[2])
par(mar = c(0,0,0,0))
plot(sf_obj, col = "#729fcf")
dev.off()
```



Color Palettes

```
carto.pal(pal1 = "blue.pal", n1 = 5,
 pal2 = sand.pal, n2 = 3)
```

```
display.carto.all(n = 8)
```

cartography - https://github.com/riatelab/cartography - CC BY SA Timothée Giraud - 2019-01