

tmap: An R Package for thematic maps

by Martijn Tennekes

Abstract A thematic map is a geographical map in which statistical data are visualized. The theme refers to the statistical phenomena that is shown, such as the unemployment rate at municipal level. The best known thematic map type is the choropleth, where regions are coloured according to a statistical variable, for instance unemployment rate. Another popular thematic map type is the bubble map, in which the sizes of the bubbles are defined by a statistical variable, for instance metropolitan population. With the **tmap** package, thematic maps can be generated with great flexibility. A thematic map is created by stacking layers, for instance one for colouring municipalities, one for thick borders of higher level regions, and one for text labels. The standard work flow that is needed to create a thematic map is embedded in tmap by several convenient functions for reading, appending, and transforming spatial data.

Introduction

Visualization is key in data science. Without looking at data, it is difficult to know the data, to unveil anomalies, and, moreover, to extract valuable knowledge (Tufte, 1983). Software tools to visually explore, analyse, and present data should therefore belong to any data scientist's toolkit. The R language and its packages contain many functions to craft elegant and clarifying graphics, most notably **ggplot2** (Wickham, 2009). However, for visualizing geospatial data, there are less straightforward options available within R. Therefore, I introduce the **tmap** package by which thematic maps can be created in a flexible way.

Thematic maps are geographic maps in which spatial data distributions are shown, such as population density. Although they are widely used for publication purposes, which is no surprise due to their visual appeal and recognizability, they also proved to be succesful for discovery and exploration of spatial data (Friendly, 1995). One of the most illustrative examples is the dot map that physician John Snow used to locate the source of the cholera outbreak in London in 1854 (Snow, 1855).

The aim of the **tmap** package is to provide R users an elegant and flexible way of making thematic maps, with a minimum of code required. The syntax resembles the syntax of **ggplot2**, and follows the layered grammar of graphics (Wickham, 2010) broadly.

An example

A thematic map of the world that has been created with **tmap** is depicted in Figure 1. It shows the relation between level of income per country and the distribution of emerging metropolitan areas. While the metropolitan areas in high income countries have a annual growth rate that is less than two percent (notice that the world population increases with 2.7 percent), metropolitan areas in lower income countries grow very fast, especially in Asia but also western and middle Africa.

The code required to create this map is the following.

```
# load spatial objects contained in tmap
data(World)
data(metro)

# derive new variable
metro$growth <- (metro$X2020 - metro$X2010) / (metro$X2010 * 10) * 100

# plot
tm_shape(World) +
  tm_fill("income_grp", style="kmeans", palette="-Blues") +
  tm_borders() +
  tm_text("iso_a3", size="AREA", scale=1.5) +
tm_shape(metro) +
  tm_bubbles("X2010", col = "growth", border.col = "black",
    border.alpha = .5, style="fixed", breaks=c(-Inf, 0, 2, 4, 6, Inf) ,
    palette="-RdYlGn", contrast=1) +
tm_layout(World(title=""), legend.titles=c(fill="Income class",
  bubble.size="Metro population (2010)", bubble.col="Annual growth rate (%)""))
```

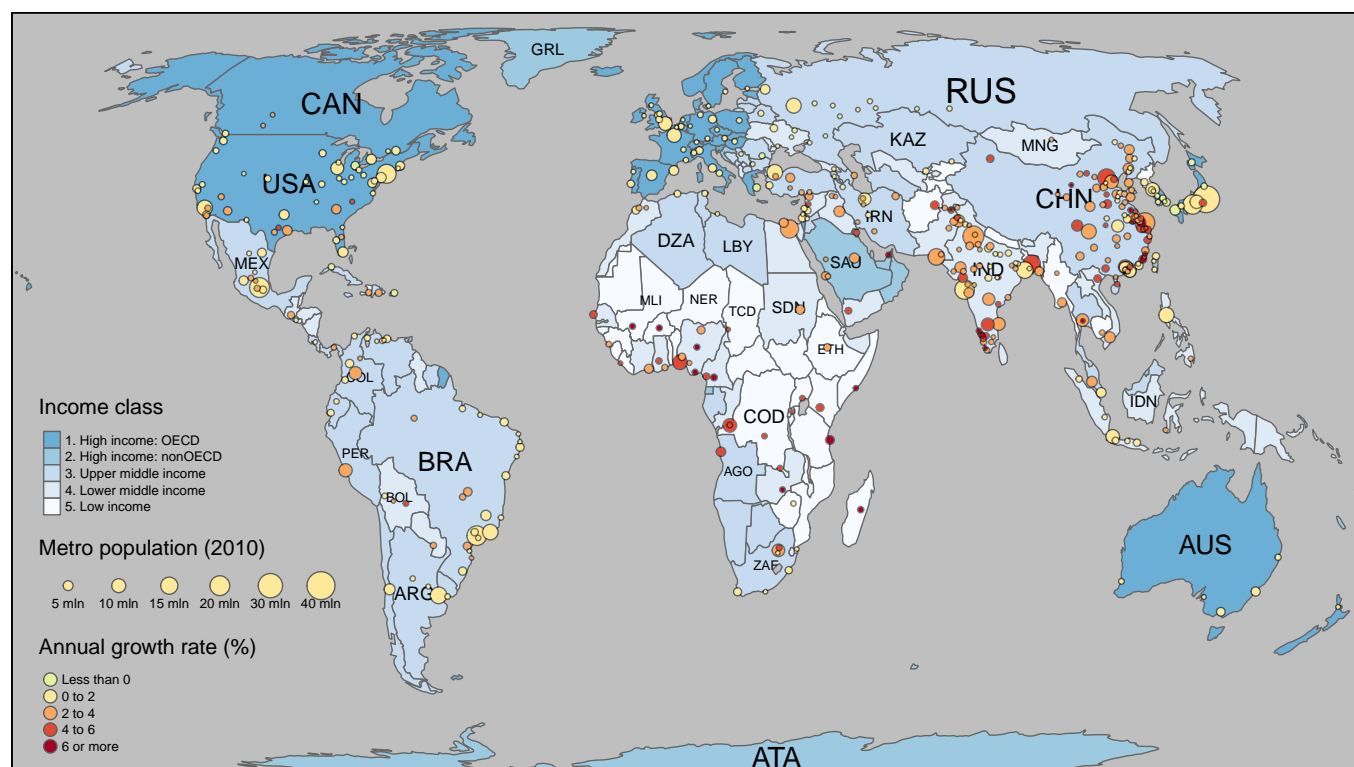


Figure 1: World map about income and urbanization.

The `#` plot part of the code is exemplified in detail in section 2.4. In a nutshell, two groups of layers are drawn. The first group defines a choropleth that uses the `SpatialPolygonsDataFrame` object `World`. The drawing layers define the fill colors of polygons (`tm_fill`), their borders (`tm_borders`), and the supplementary text labels (`tm_text`). The second group defines a bubble map based on the `SpatialPointsDataFrame` `metro`. The only layer consist of the bubbles created by `tm_bubbles`.

Related R-packages

The `tmap` package stands on the shoulders of the following six great packages.

sp (Pebesma, 2005; Roger S. Bivand, 2013) This package contains classes and methods for spatial data. Only spatial objects from `SpatialPolygons(DataFrame)`, `SpatialPoints(DataFrame)` and `SpatialLines(DataFrame)` are accepted.

rgdal (Bivand et al., 2014) Processing ESRI shape files is done by this package, as well as map projections via PROJ.4 library (Warmerdam and Evenden, 2012).

rgeos (Bivand and Rundel, 2014) All geometric processing is carried out by this package.

classInt (Bivand, 2015) This package facilitates class intervals, which are used in choropleths of quantitative variables.

RColorBrewer (Bivand, 2015) All used color schemes have been proposed by Brewer et al. (2003) and implemented in this package.

grid This package provides all basic plotting functions.

Syntax

Another section

There will likely be several sections, perhaps including code snippets, such as:

Summary

This file is only a basic article template. For full details of *The R Journal* style and information on how to prepare your article for submission, see the [Instructions for Authors](#).

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