Tutorial: Making maps with R

from base (rock) to shiny (clouds)

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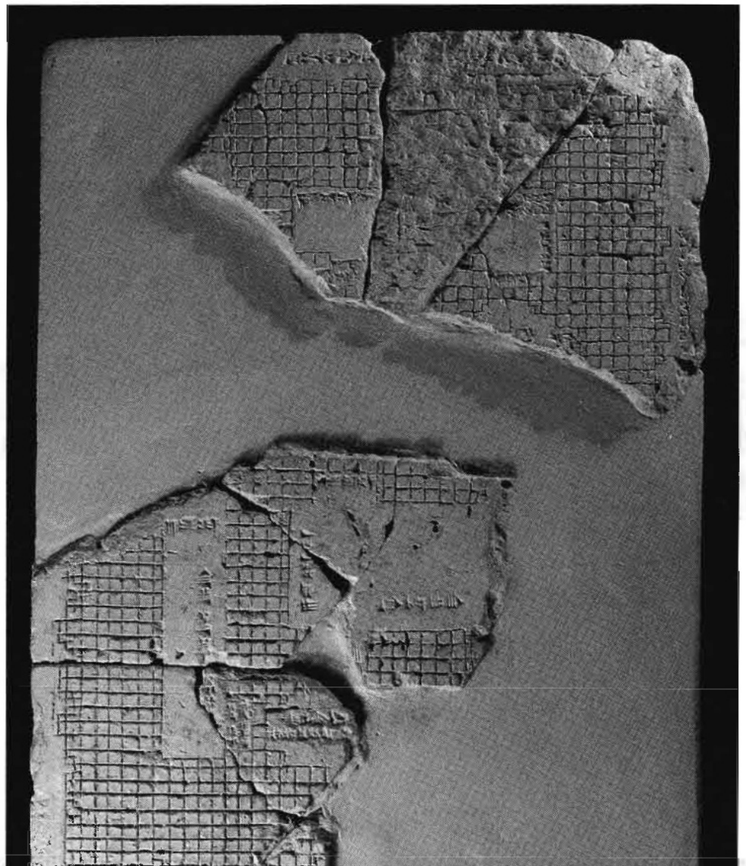
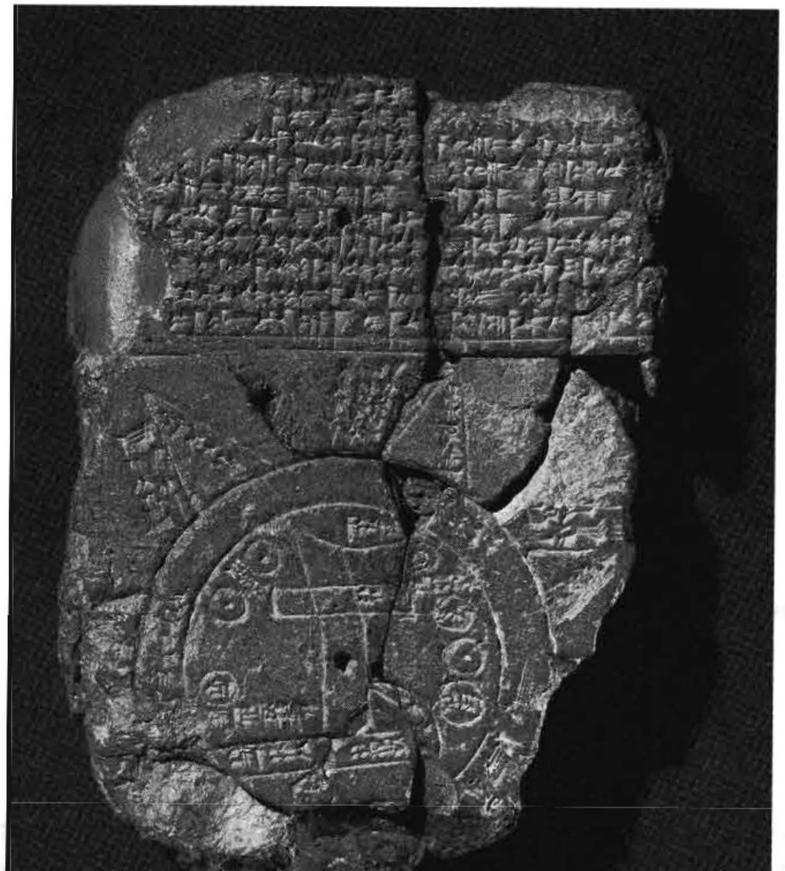
A brief history of geographic vizualisation I

- Neo Babylonian (626 BC - 539 BC) temple plan Source: (Talbert, 2014)



A brief history of geographic vizualisation II

- Late Babylonian (1000 BC - 606 BC) map of the world Source: (Talbert, 2014)



A brief history of geographic vizualisation III

- The mappa mundi - largest Mediaval map surviving (~1300 **AD**)

A brief history of geographic data viz in R

"The core R engine was not designed specifically for the display and analysis of maps, and the limited interactive facilities it offers have drawbacks in this area" (Bivand, Pebesma, and Gómez-Rubio, 2013).

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Five years later...

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Five years later...

"An example showing R's flexibility and evolving geographic capabilities is **leaflet** (Cheng, Karambelkar, and Xie, 2018), a package for making interactive maps that has been extended by the R community, as we'll see in Chapter 9" (Lovelace, Nowosad, and Meunchow, 2018).

R's 'base' graphics: sp

Base R graphics: sp code

Credit: asdar-book.org/, reproducible code accompanying the book Applied Spatial Data Analysis with R (Pebesma et al. 2013).

```
library(sp)
library(spData)
nz_sp = as(nz, "Spatial")
plot(nz_height_sp, cex = 2)
title("points")
plot(nz_sp, col = "grey")
plot(nz_height, add = TRUE, col = "red")
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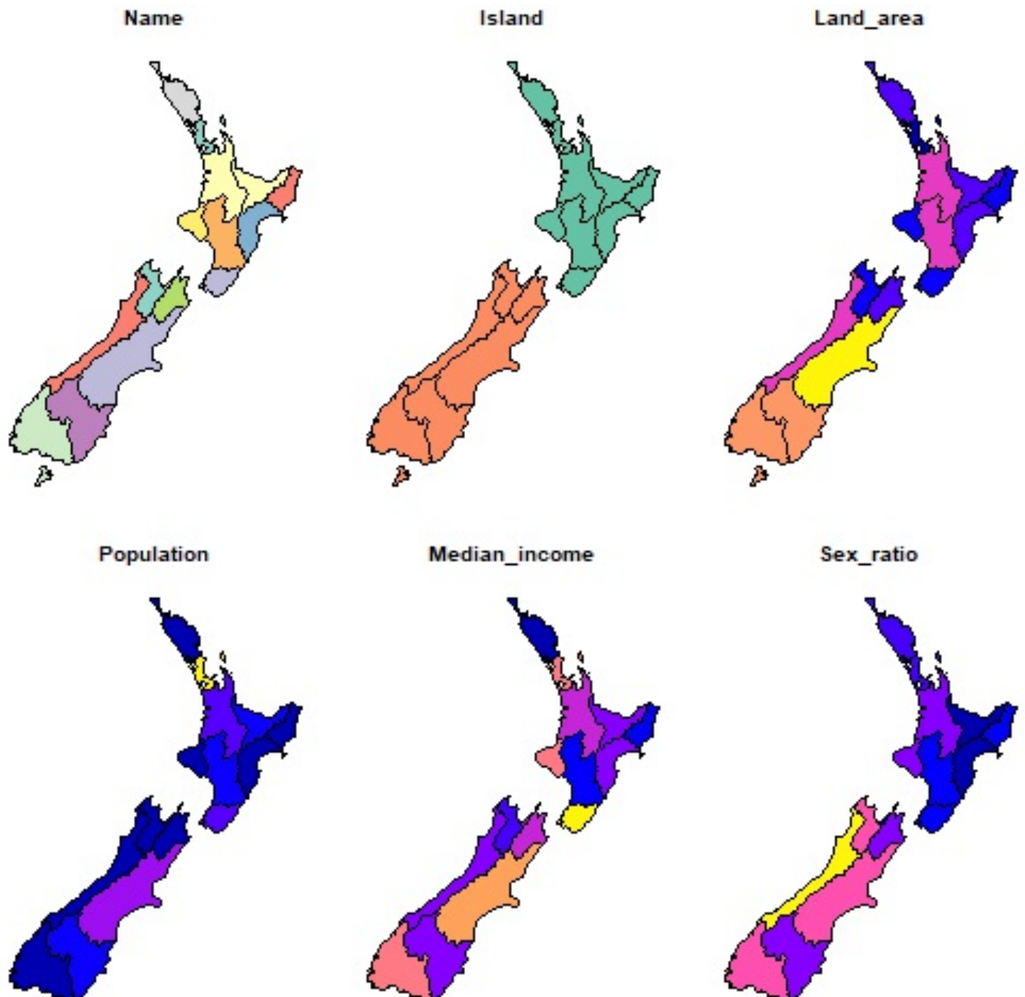
Observations

- Passes arguments (e.g `cex` for symbol size) to `graphics::plot()`
- New command for each additional 'layer' (e.g. `title()`, `plot(..., add = TRUE)`)
- Black and white default output style
- Fast

Base R graphics: sf

```
plot(nz)
```

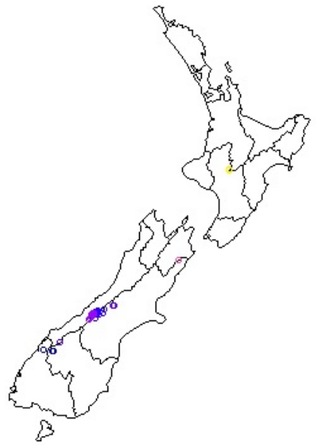


Base R graphics: sf II

```
plot(st_geometry(nz))
plot(nz_height, add = TRUE)
```

```
## Warning in plot.sf(nz_height, add = TRUE): ignoring all but the first
## attribute
```

```
sf_cols = sf.colors(n = 2, alpha = 0.2)
nz$col = factor(x = nz$Island, labels = sf_cols)
plot(st_geometry(nz), col = as.character(nz$col))
```



sf graphics: code

```
# facet plots by default
plot(nz)
# plot just geometry, ready for new layers:
plot(st_geometry(nz), reset = FALSE)
# addition of new layers
plot(nz_height, add = TRUE)
# transparency
sf_cols = sf.colors(n = 2, alpha = 0.2)
nz$col = factor(x = nz$Island, labels = sf_cols)
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#  see ?plot.sf for more
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```

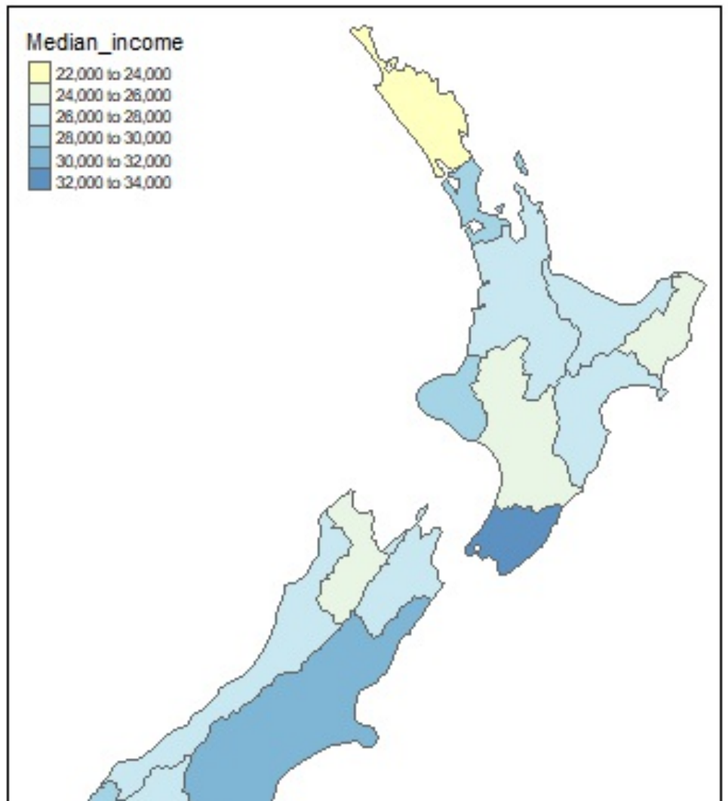
Observations

- Facets by default: useful for seeing patterns.
- Transparency new, `add = ...` argument the sam.e
- You can go far with base R graphics (Murrell, 2016).

tmap

- A diverse dedicated mapping R package

```
library(tmap)
tm_shape(nz) +
  tm_polygons("Median_income", palette = "RdYlBu")
```



Why tmap?

- It is powerful and flexible.
- Concise syntax, attractive maps with minimal code, familiar to **ggplot2** users.
- Unique capability: same code -> static + interactive maps with switch `tmap_mode()`.
- Wide range of spatial classes (including `raster` objects) supported.
- Well documented + developed --- see `tmap-nutshell` and JSS paper (Tennekes, 2018).

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- It's also at eRum!
- At 13:30 in room N15 203: "Plotting spatial data in R".

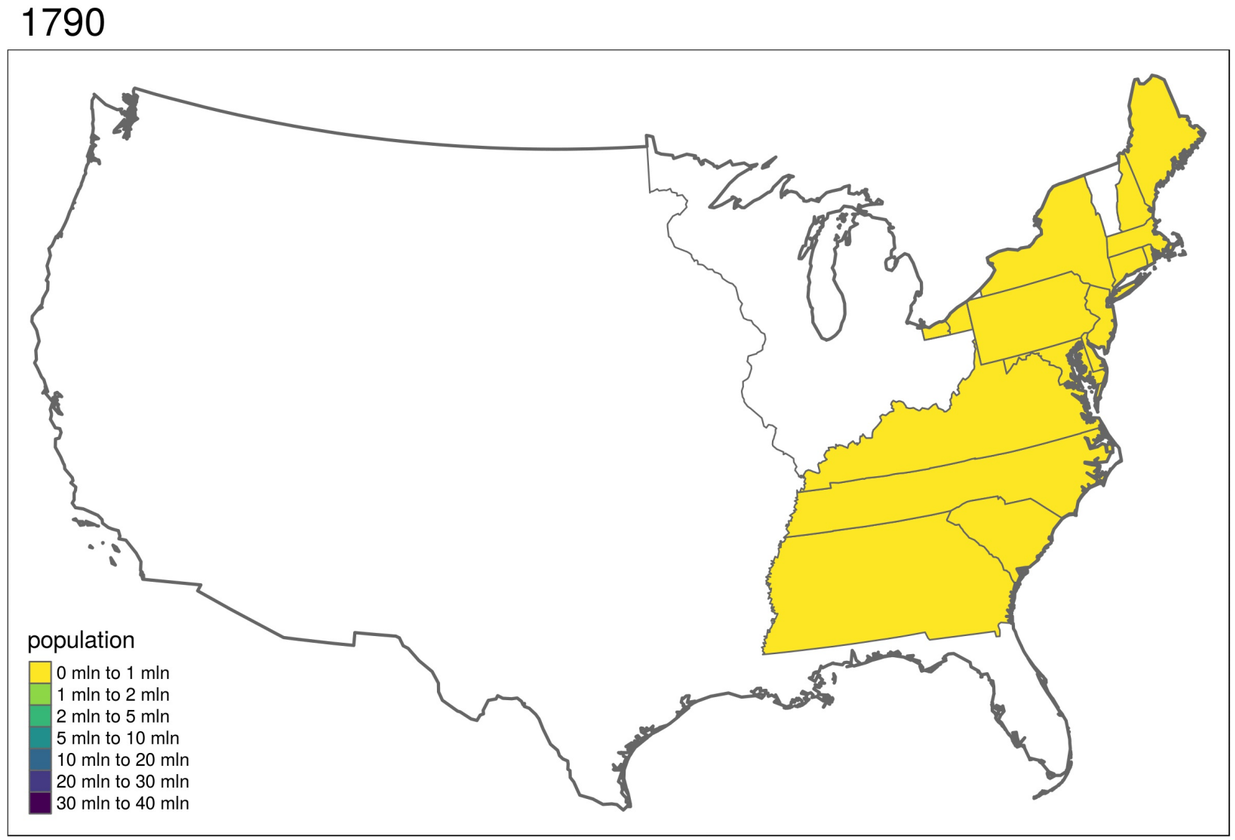
tmap basics

```
# Add fill layer to nz shape
tm_shape(nz) + tm_fill()
# Add border layer to nz shape
tm_shape(nz) + tm_borders()
# Add fill and border layers to nz shape
tm_shape(nz) + tm_fill() + tm_borders()
```

tmap basics

Animations

- Are easy with **tmap** (section 9.3 of geocompr)

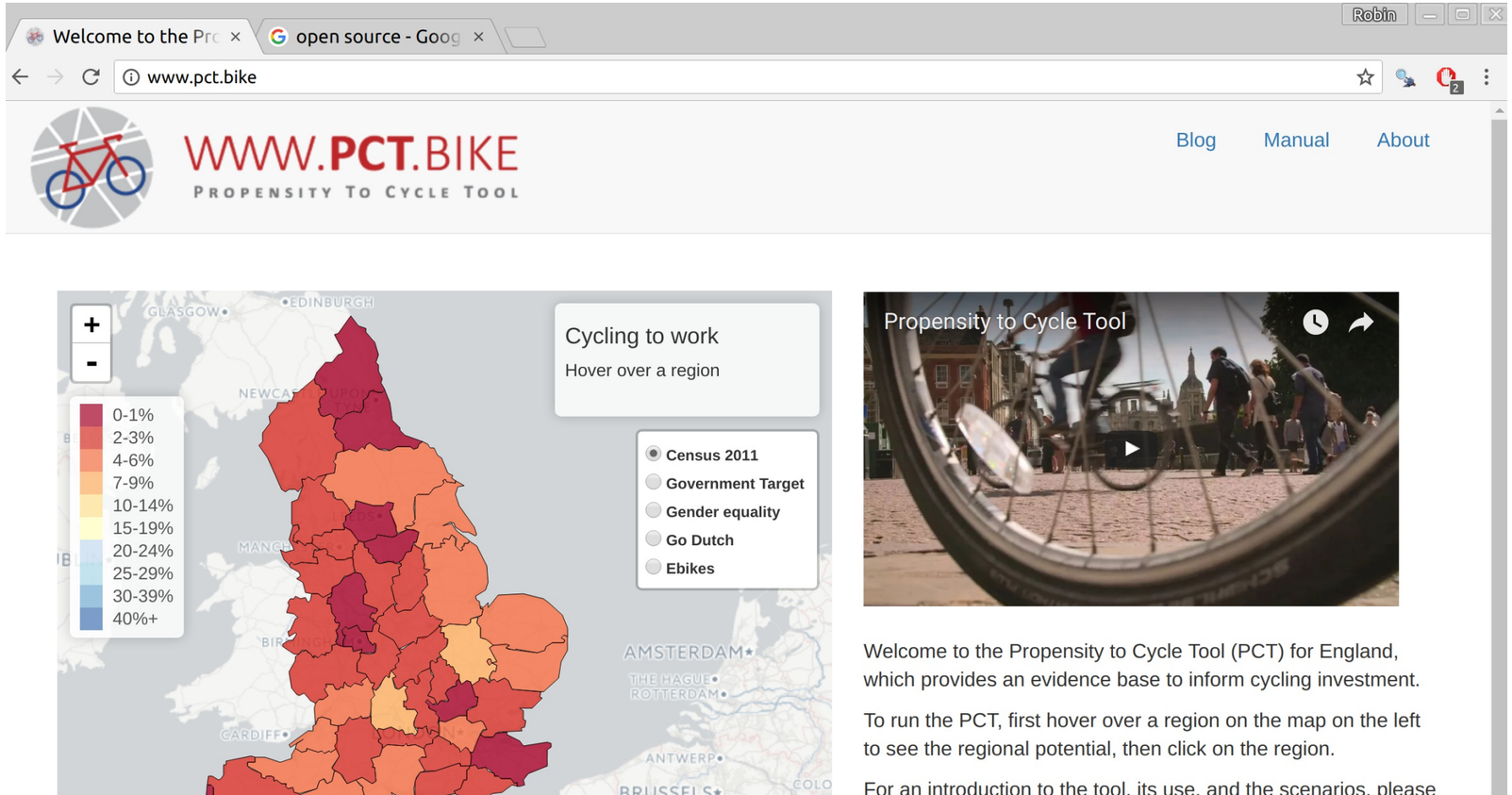


Interactive maps with mapview

```
m = mapview::mapview(nz)
m@map
```

Web mapping applications

- Leaflet integrates with **shiny** via `leaflet::leafletOutput()`, enabling web mapping applications built on R
- These can be set-up to scale nationally, as illustrated by pct.bike (Lovelace, Goodman, Aldred, Berkoff, Abbas, and Woodcock, 2017).



Exercises

1. Create a map showing the geographic distribution of the Human Development Index (`HDI`) across Africa with -base graphics (hint: use `plot()`) and -**tmap** (hint: use `tm_shape(africa) + ...`).
    - Name two advantages of each approach
    - Bonus: What three other mapping packages could be used to show the same data?

Exercises

1. Create a map showing the geographic distribution of the Human Development Index (**HDI**) across Africa with -base graphics (hint: use **`plot()`**) and -**tmap** (hint: use **`tm_shape(africa) + ...`**).
   - Name two advantages of each approach
   - Bonus: What three other mapping packages could be used to show the same data?

Starting point for the exercise:

```
library(sf)
library(spData)
library(tidyverse)
africa = world %>%
  filter(continent == "Africa", !is.na(iso_a2)) %>%
  left_join(worldbank_df, by = "iso_a2") %>%
  select(name, subregion, gdpPercap, HDI, pop_growth) %>%
  st_transform("+proj=aea +lat_1=20 +lat_2=-23 +lat_0=0 +lon_0=25")
```

References

Bivand, Roger S, Edzer Pebesma and Virgilio GÃ³mez-Rubio (2013). *Applied Spatial Data Analysis with R*. 2nd ed. 2013 edition. New York: Springer. 405 pp. ISBN: 978-1-4614-7617-7.

Cheng, Joe, Bhaskar Karambelkar and Yihui Xie (2018). *Leaflet: Create Interactive Web Maps with the JavaScript 'Leaflet' Library*. R package version 2.0.0. URL: https://CRAN.R-project.org/package=leaflet.

Lovelace, Robin, Anna Goodman, Rachel Aldred, et al. (2017). "The Propensity to Cycle Tool: An Open Source Online System for Sustainable Transport Planning". In: *Journal of Transport and Land Use* 10.1. ISSN: 1938-7849. DOI: 10.5198/jtlu.2016.862. URL: https://www.jtlu.org/index.php/jtlu/article/view/862 (visited on Jun. 01, 2017).

Lovelace, Robin, Jakub Nowosad and Jannes Meunchow (2018). *Geocomputation with R*. CRC Press. URL: http://robinlovelace.net/geocompr (visited on Okt. 05, 2017).

Murrell, Paul (2016). *R Graphics, Second Edition*. CRC Press. 536 pp. ISBN: 978-1-4398-3177-9. Google Books: googlebooks.

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Tennekes, Martijn (2018). "Tmap: Thematic Maps in R". In: *Journal of Statistical Software, Articles* 84.6, pp. 1-39. ISSN: 1548-7660. DOI: 10.18637/jss.v084.i06. URL: https://www.jstatsoft.org/v084/i06.