Introduction to $\mathcal{R}$

Session 4. ggplot2 Graphics

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November 8/9, 2019

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Introduction

Before we start...

Here is our in-class solution to yesterday's puzzle. We have built in a semantic error. Can you spot and fix it? Hint: Try different parameter settings.

```
r <- 1; n <- 10000
hits <- vector("logical", length = n)
for (i in seq(n)) {
    hits[i] <- sqrt(sum(runif(2, -r, r) ^ 2)) <= 1
}
4 * mean(hits)
```

Before we start...

In 1987, the Indiana General Assembly attempted to establish the value of π by legislative fiat. The Indiana Pi Bill goes back to Edward J. Goodwin's scientifically proven method to square the circle.

```
pi; pi <- 3.2; pi; base::pi
```

```
## [1] 3.141593
```

```
## [1] 3.2
```

```
## [1] 3.141593
```

Now, an object sits on your workspace that has name pi and value 3.2. You can still access the mathematical constant, though. See the manual: `?"::"`.

Today's Agenda

- **Place**: Campus Griebnitzsee, House 7, Room 2.41
- **Coffee break**: 10:45 - 11:00
- **Lunch break**: 12:30 - 13:30
- **Materials**: Go to https://github.com/dagtann/pcqr/

Day	Start	End	Official Topic
2	09:15	10:45	Graphics
	11:00	12:30	Basic Statistics
	13:30	15:00	(G)LMs

A Taste of ggplot2

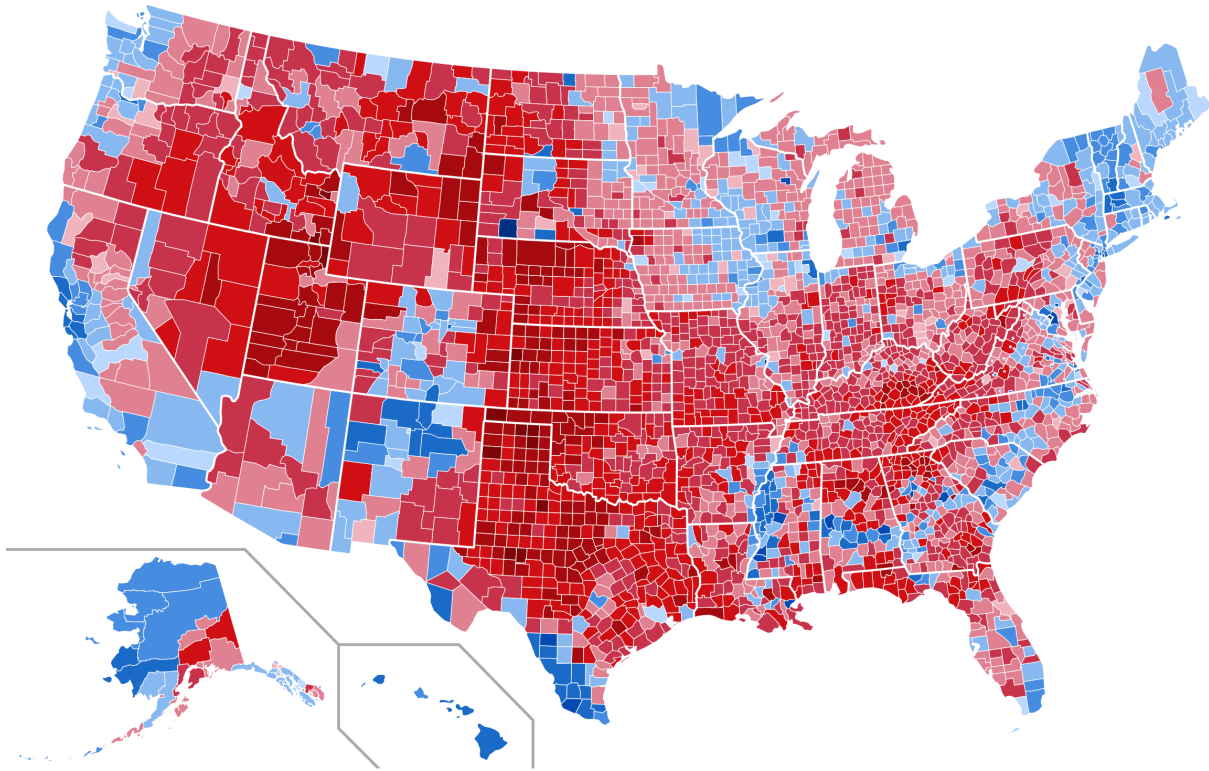


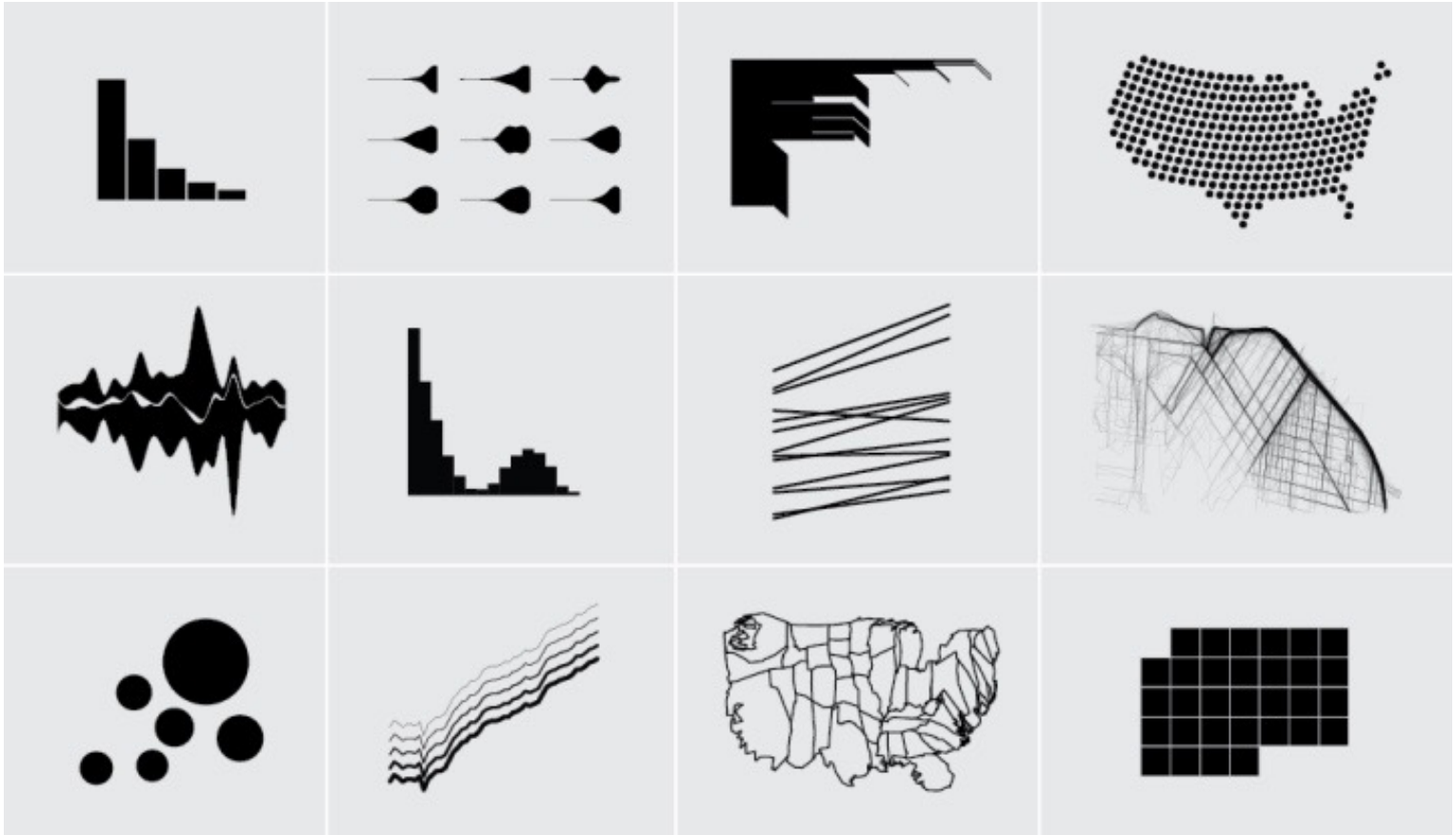
Figure 1: Vote Share in the 2012 Presidential Elections by County[2]

[2] Healan, K. 2019. Data Visualization. A Practical Introduction. Princeton: Princeton University Press, https://socviz.co/maps.html (last access: 11/05/2019).

Second Serving: Hierarchical Edge Bundling[3]

[3] Holtz, Y. 2017. The R Graph Gallery. https://bit.ly/2QKdhLU (last access: 11/05/2019).

An Embarassing Riches of Options[4]



[4] Yau, N. 2016. 5 Tips for Learning to Code for Vizualization. https://bit.ly/2yu0fe0 (last access: 10/11/2018).

Outline

What is ggplot2?

Graphics Engines in $\mathcal{R}$

- Three major graphics systems in $\mathcal{R}$
  - base graphics: ships with $\mathcal{R}$[5]
  - lattice developed by Deepayan Sarkar
  - ggplot2 developed by Hadley Wickham
- All build on Paul Murrell's grid Graphics
- All differ remarkbly on usability & quality of output

[5] Check out Nathan Yau's tutorials at Flowing Data.

What's the buzz about ggplot2?

- Implements the Grammar of Graphics[6]

  "In brief, the grammar tells us that a statistical graphic is a mapping from data to aesthetic attributes (colour, shape, size) of geometric objects (points, lines, bars)."[7]

- Very generic, schematic approach to data viz
- Seamless integration with tidyverse
- Numerous extensions: Animations, maps, dags, etc.
- Delivers high quality results – fast.

[6] Wilkinson, L. 1999/2005. The Grammar of Graphics. New York: Springer Science + Business.

[7] Wickham, H. 2016. ggplot2. 2^8 ed. New York: Springer Science + Business.

How do you talk to ggplot2?

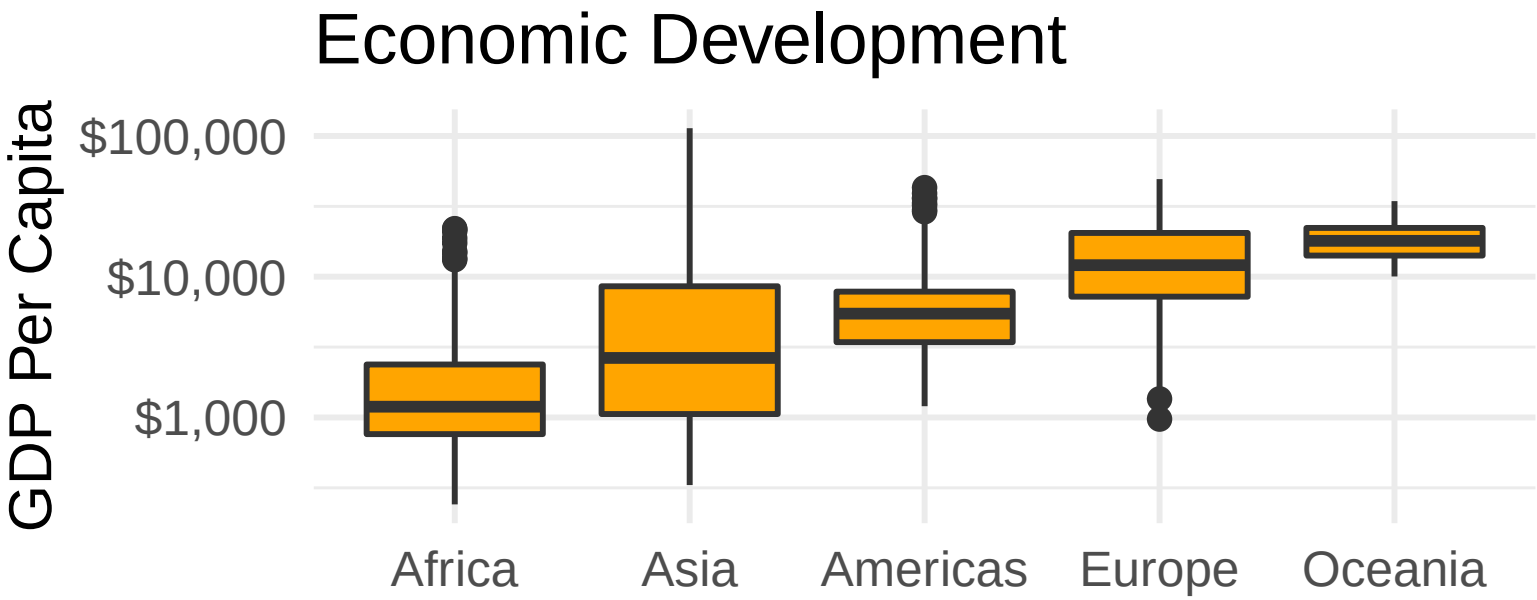
Intuition

- Idea: logical connection b/w data & plot elements
  - Example: Gender $\mapsto$ Color
  - a.k.a. aesthetic mapping
- Answer the following questions for ggplot2:
  1. What is your data?
  2. What relationships do you want to see?
  3. How do you want to see it?
  4. What additional information do you want to see?
  5. What scales, axes, labels should be shown?
- Complete reference:
  - Hadley's book: ggplot2
  - ggplot2 Online Reference: tidyverse
  - Kieran Healy's book: Data Vizualization

A Schematic for Making a Plot

```
p <- ggplot(
    data = <data>, # 1. What is your ("tidy") data?
    mapping = aes( # 2. What var's map unto the plot?
        <aesthetic> = <variable>, # x
        <aesthetic> = <variable>, # y
        <...> = <...> # colour, fill, shape, size,
          # alpha, ...
    )
) + # Add layers to your plot
  geom_<type>(<...>) + # Define your plot type
  scale_<mapping>_<type>(<...>) +  # Adjust scales
  coord_<type>(<...>) + # Adjust co-ordinates
  labs(<...>) # Label plot elements
ggsave(file = <...>, plot = <...>, ...) # Save ur work
```

Our Target Graph



Source: Gapminder.

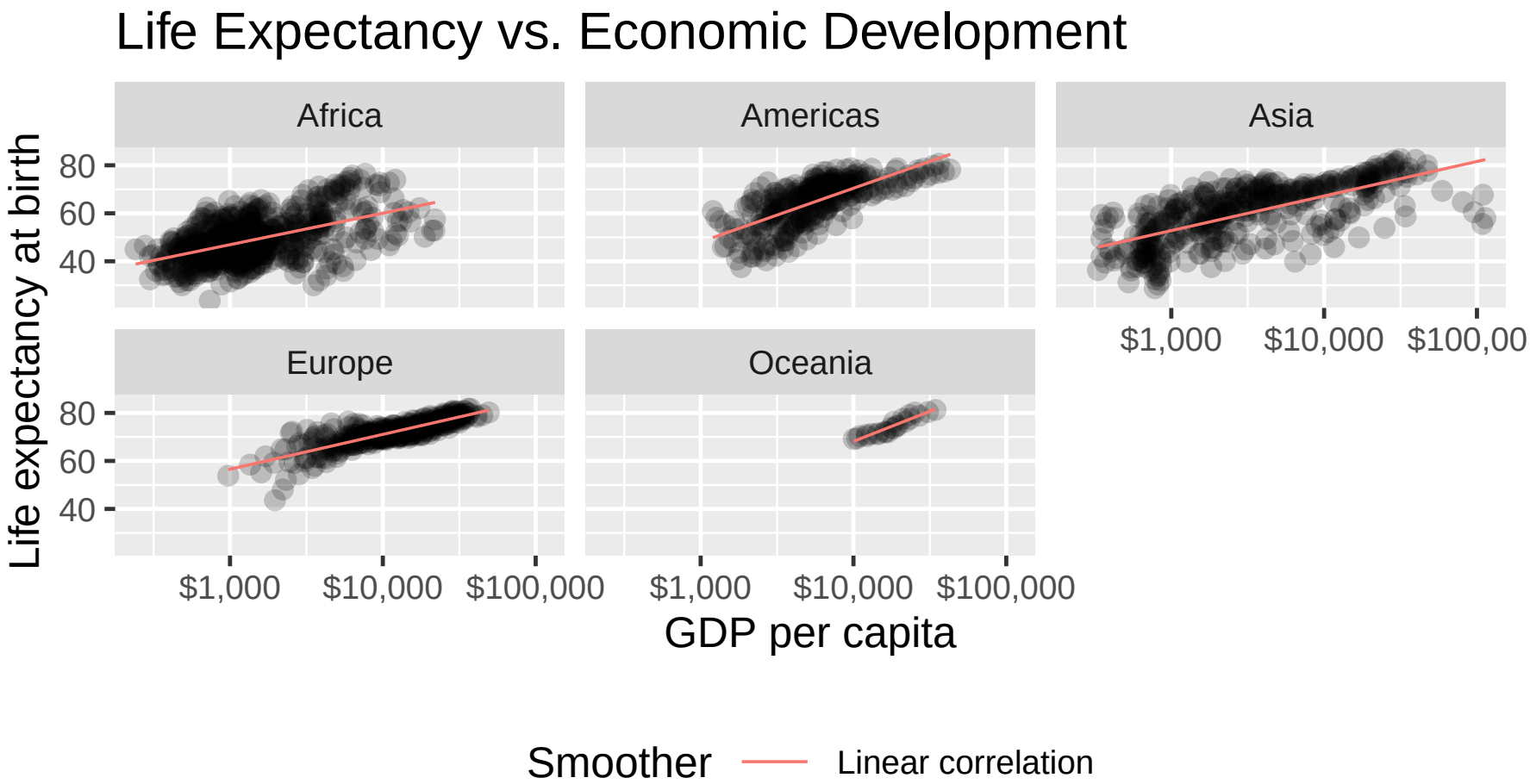
- Open the notebook file notebook_04.Rmd.
- Using the notebook, answer questions 1-5.
- Use the generic schematic and tidyverse to generate the plot.

Summary

Summary

- There are three major graphics engines: base, ggplot, lattice.
- ggplot2's attraction
  - very generic, schematic approach to viz
  - fast, visually pleasing results
- Principle strategie:
  a. Connect (map) data to plot elements
  b. Layer plot elements
- Read Healan, K. 2019. Data Visualization. A Practical Introduction. Princeton: Princeton University Press. Avaliable at https://socviz.co/ (last access: 11/05/2019).

Self-practice: Replicate these figures.



Self-practice: Replicate this figure.