Exploratory data analysis using visualization & Data organization in spreadsheets

CVEN 5999 - Summer 2025

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cven5999-ss25.github.io/website/

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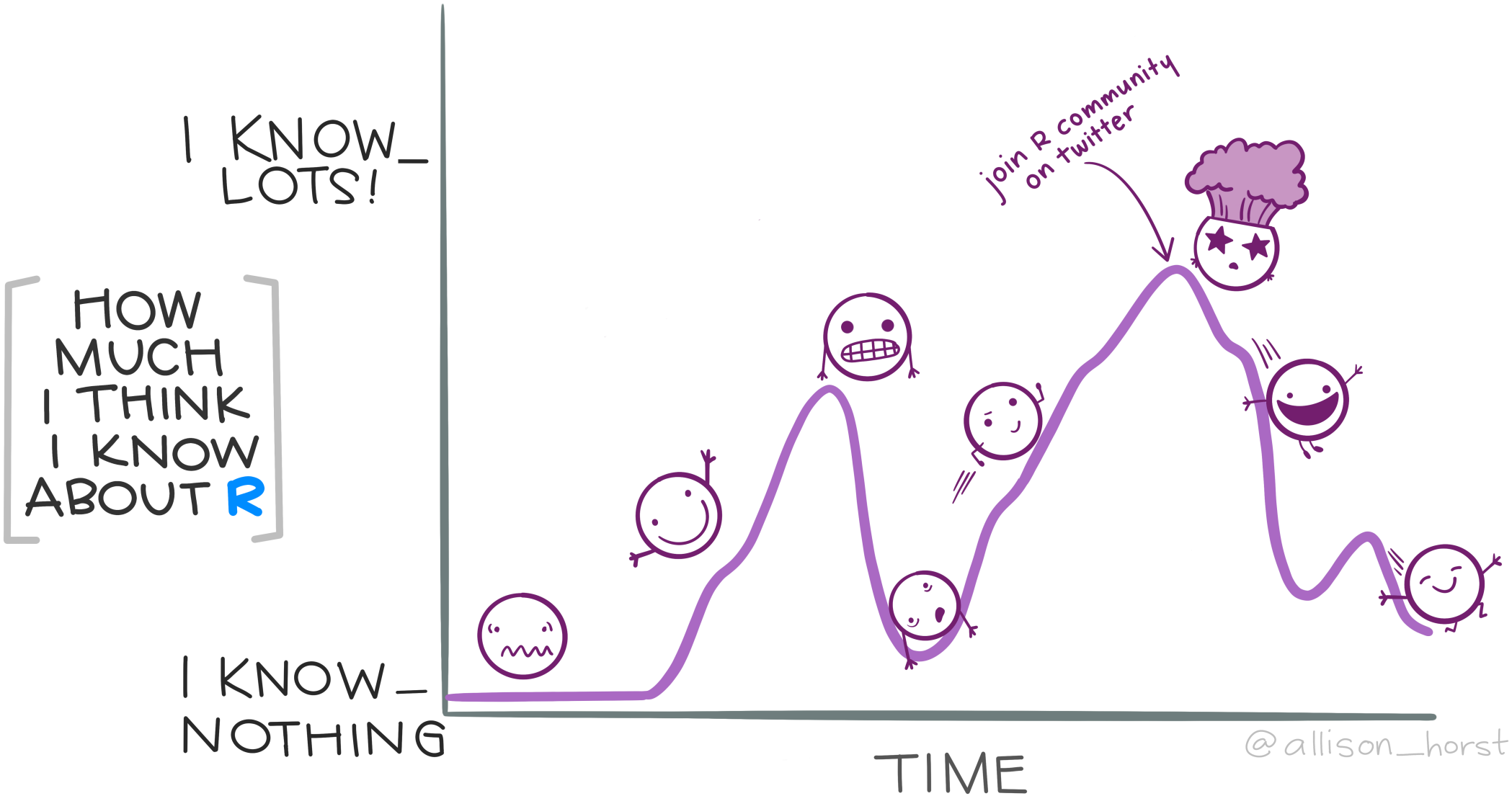
UNIVERSITY OF COLORADO BOULDER


I KNOW LOTS!
HOW MUCH I THINK I KNOW ABOUT R
I KNOW NOTHING
join R community on twitter
TIME
@allison_horst

Solving coding problems

Tipps for search engines

- Use actionable verbs that describe what you want to do
- Be specific
- Add R to the search query
- Add the name of the R package name to the search query
- Scroll through the top 5 results (don’t just pick the first)

Example: “How to remove a legend from a plot in R ggplot2”

Stack Overflow

What is it?

- The biggest support network for (coding) problems
- Can be intimidating at first
- Up-vote system

Workflow

- First, briefly read the question that was posted
- Then, read the answer marked as “correct”
- Then, read one or two more answers with high votes
- Then, check out the “Linked” posts
- Always give credit for the solution

Tipps for AI tools

- Use actionable verbs that describe what you want to do
- Be specific
- Add R to the search query
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Example: “How to remove a legend from a plot in R ggplot2”

Other sources for help

- Posit Community Forum: https://forum.posit.co/
- Documentation websites: https://dplyr.tidyverse.org/
- bsky community: https://bsky.app/hashtag/RStats

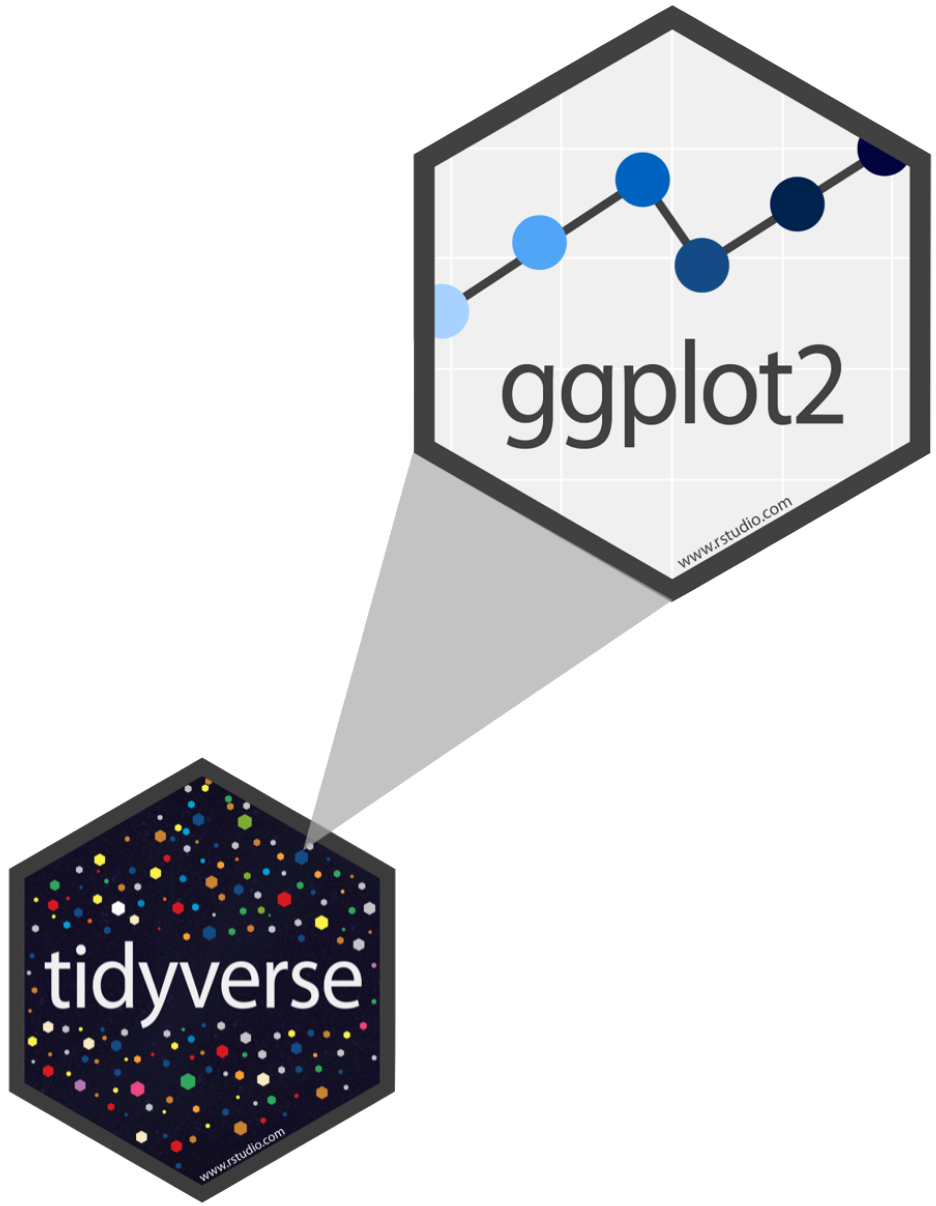
Learning Objectives (for this week)

1. Learners can describe the four main aesthetic mappings that can be used to visualise data using the ggplot2 R Package.
2. Learners can control the colour scaling applied to a plot using colour as an aesthetic mapping.
3. Learners can compare three different geoms and their use case.
4. Learners can apply a theme to control font types and sizes within a plot.
5. Learners can apply 12 principles for data organisation in spreadsheets in the layout of a collected dataset.

Exploratory Data Analysis with `ggplot2`

R Package `ggplot2`

- **ggplot2** is tidyverse's data visualization package
- `gg` in `ggplot2` stands for Grammar of Graphics
- Inspired by the book **Grammar of Graphics** by Leland Wilkinson
- **Documentation:** https://ggplot2.tidyverse.org/
- **Book**: https://ggplot2-book.org



Code structure

- `ggplot()` is the main function in ggplot2
- Plots are constructed in layers
- Structure of the code for plots can be summarized as

```
ggplot(data = [dataset],
       mapping = aes(x = [x-variable],
                     y = [y-variable])) +
   geom_xxx() +
   other options
```

Code structure

```
1 ggplot()
```

Code structure

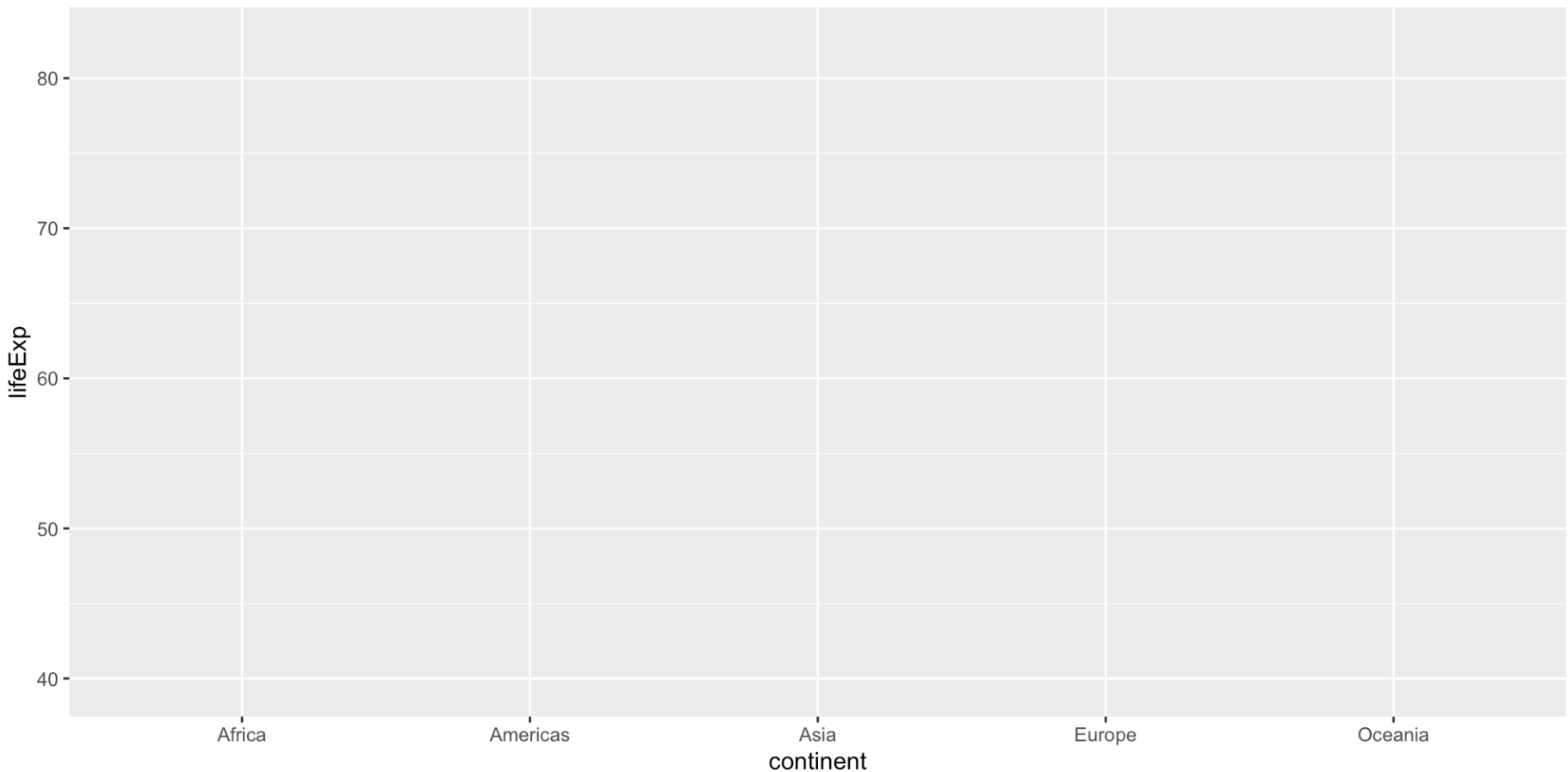
```
ggplot(data = gapminder_yr_2007)
```

Code structure

```
1  ggplot(data = gapminder_yr_2007,
2         mapping = aes())
```

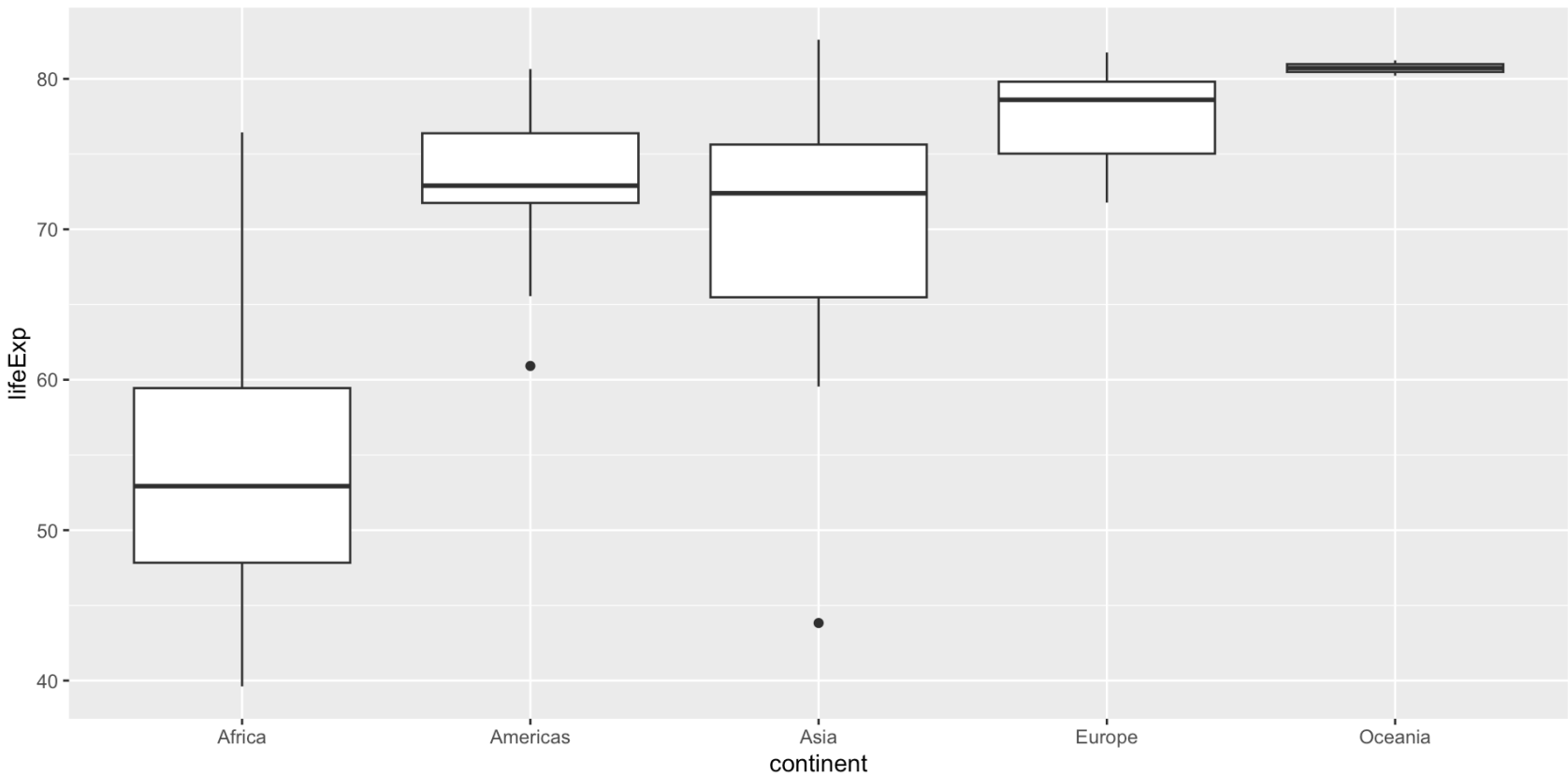
Code structure

```
1  ggplot(data = gapminder_yr_2007,
2         mapping = aes(x = continent,
3                       y = lifeExp))
```



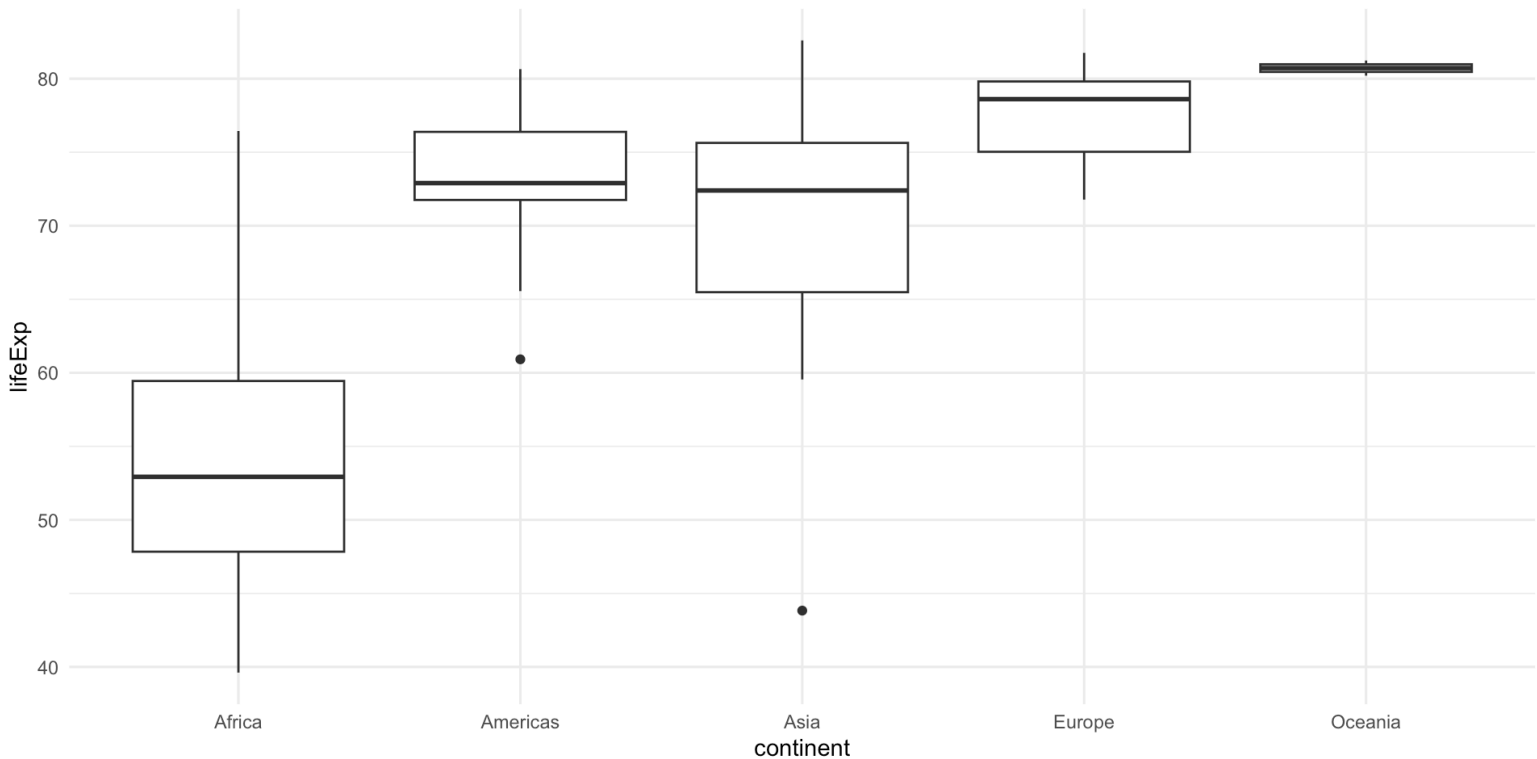
Code structure

```
ggplot(data = gapminder_yr_2007,
       mapping = aes(x = continent,
                     y = lifeExp)) +
  geom_boxplot()
```



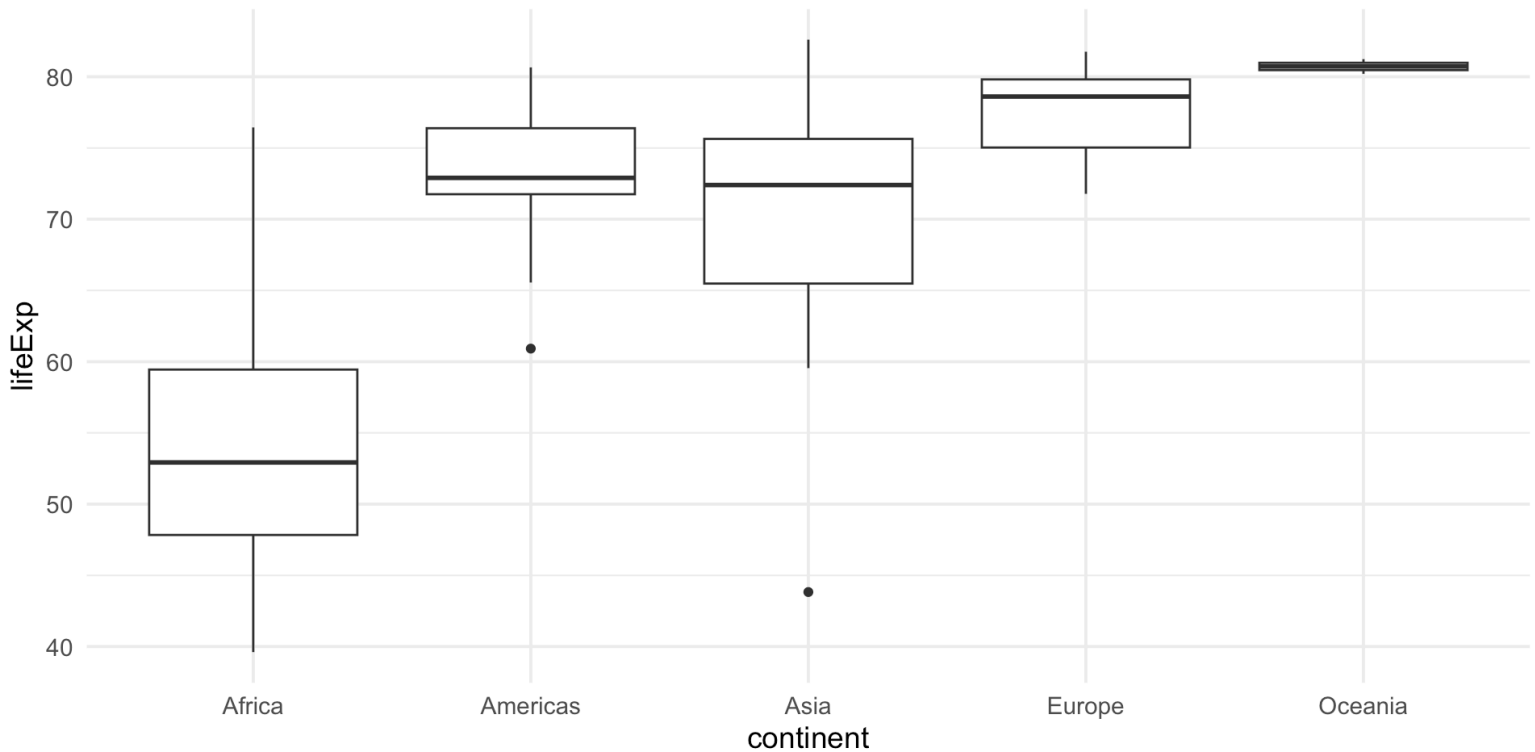
Code structure

```
ggplot(data = gapminder_yr_2007,
       mapping = aes(x = continent,
                     y = lifeExp)) +
  geom_boxplot() +
  theme_minimal()
```



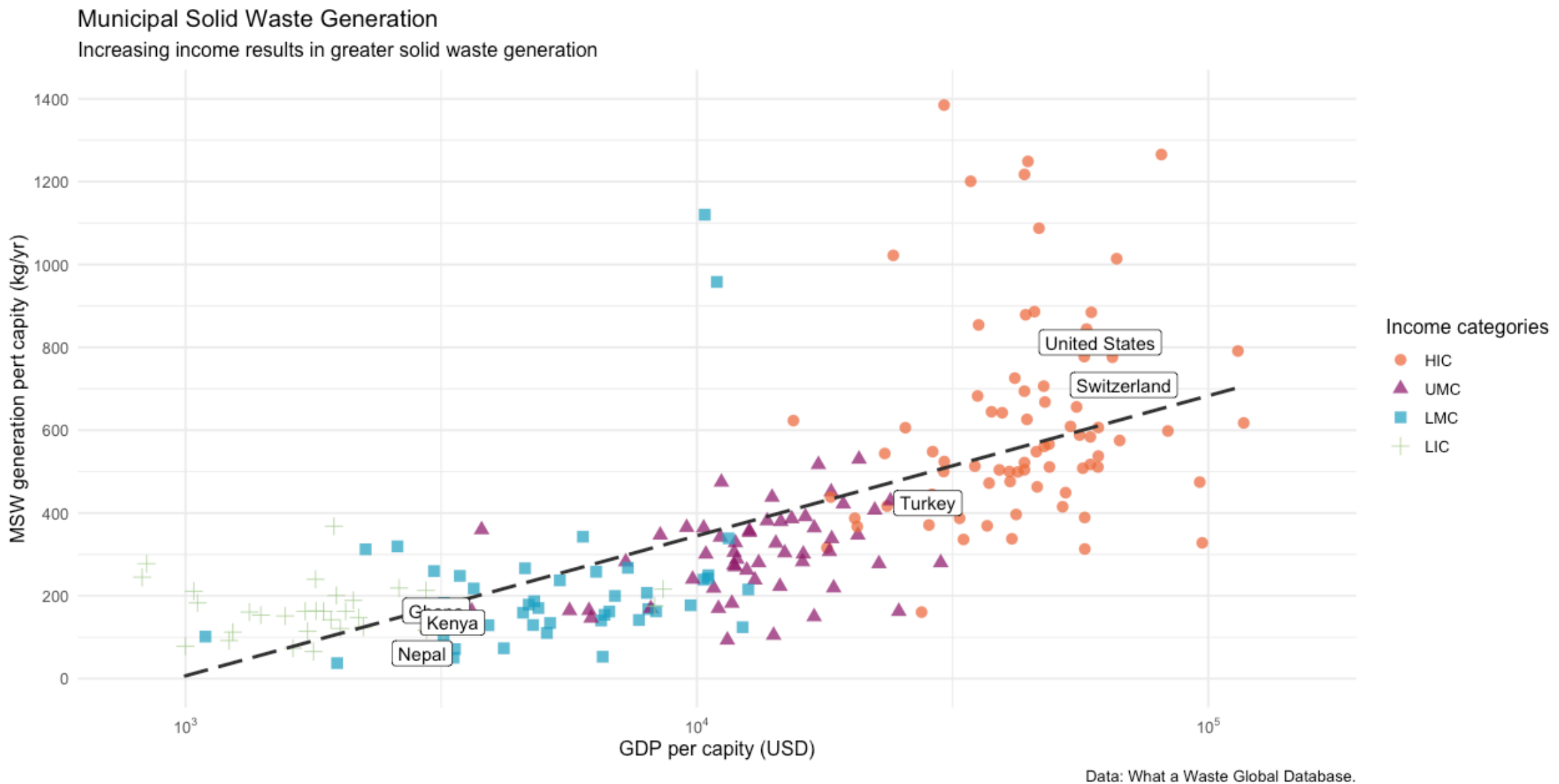
Code structure

```
ggplot(data = gapminder_yr_2007,
       mapping = aes(x = continent,
                     y = lifeExp)) +
  geom_boxplot() +
  theme_minimal(base_size = 14)
```



Live Coding Exercise: Reproduce this plot

cven5999-ss25.github.io/website/


Municipal Solid Waste Generation
Increasing income results in greater solid waste generation
MSW generation pert capity (kg/yr)
1400
1200
1000
800
600
400
200
0
10^3
10^4
10^5
GDP per capity (USD)
United States
Switzerland
Turkey
Kenya
Nepal
Income categories
HIC
UMC
LMC
LIC
Data: What a Waste Global Database.

live-data-visualiation

1. Head over to posit.cloud
2. Open the workspace for the course cven5999-ss25
3. Open “Projects”
4. Open the “course-materials” project
5. Follow along with me

Break

10:00

Photo by Blake Wisz

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Visualising numerical data

Types of variables

numerical

discrete variables

- non-negative
- whole numbers
- e.g. number of students, roll of a dice

continuous variables

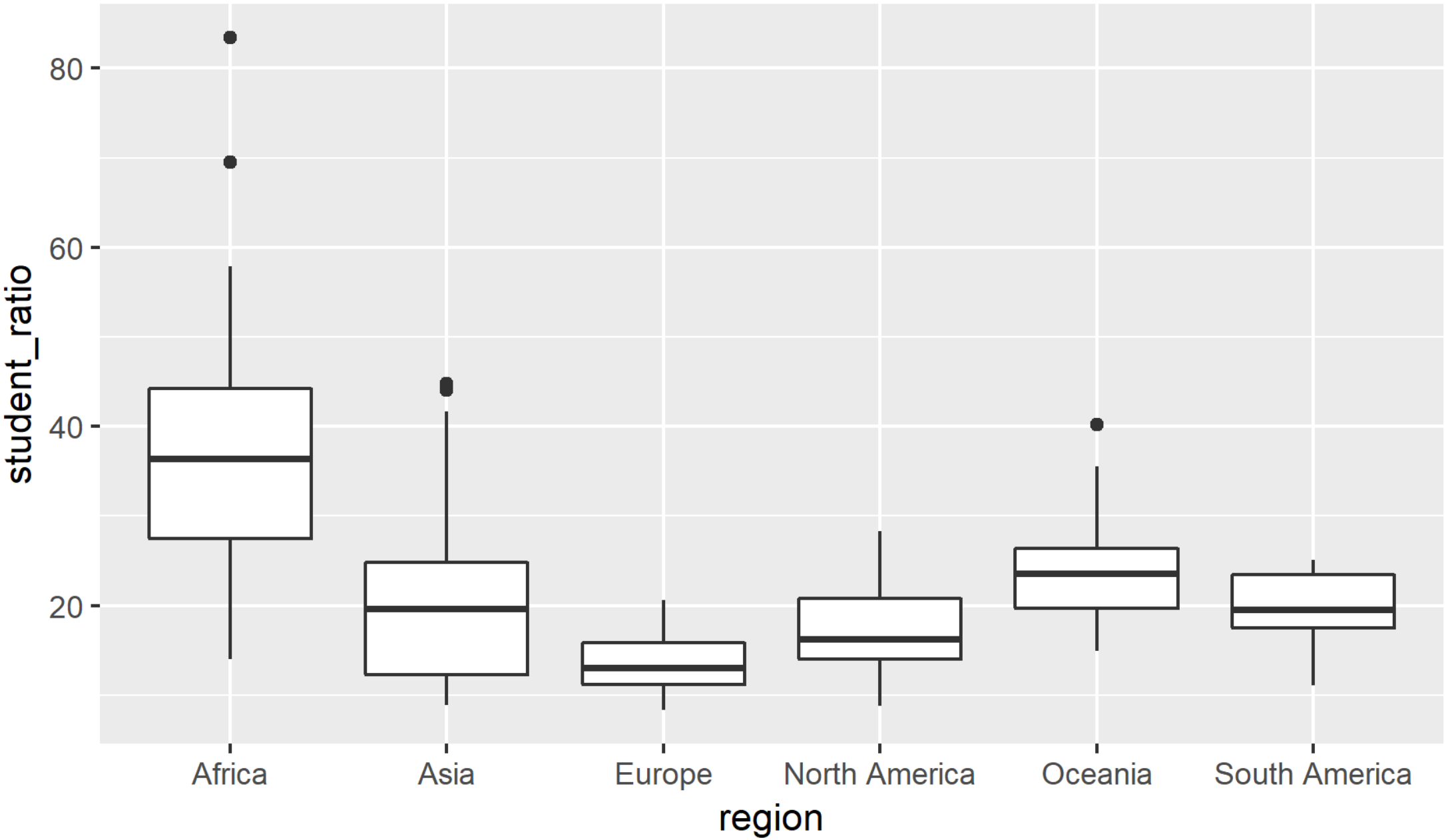
- infinite number of values
- also dates and times
- e.g. length, weight, size

non-numerical

categorical variables

- finite number of values
- distinct groups (e.g. EU countries, continents)
- **ordinal** if levels have natural ordering (e.g. week days, school grades)

The Evolution of a ggplot



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Data: UNESCO Institute for Statistics
Visualization by Cédric Scherer

Data Organisation in Spreadsheets


Listen

Article

Data Organization in Spreadsheets

Karl W. Broman & Kara H. Woo

Pages 2-10 | Received 01 Jun 2017, Accepted author version posted online: 29 Sep 2017, Published online:24 Apr 2018

Download citation https://doi.org/10.1080/00031305.2017.1375989 Check for updates

Jorunal: The American Statistician, Screenshot taken on 2022-03-23

Data Organisation in Spreadsheets

Read the paper (it's part of your homework), but you can also:

- Go through the annotated slides: https://kbroman.org/Talk_DataOrg/dataorg_notes.pdf
- Watch Karl Broman give the talk (02:36 to 45:00): https://youtu.be/t74E0a90gkA?t=156
- Read the content on a website: https://kbroman.org/dataorg/

But, especially apply it to your data

Why?

Because it will make your life easier!

via GIPHY

Editorial

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Ronald L. Wasserstein & Nicole A. Lazar

Published online: 9 Jun 2016 (Vol.70, No.2, 2016)

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Editorial

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Ronald L. Wasserstein, Allen L. Schirm & Nicole A. Lazar

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Article

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Karl W. Broman & Kara H. Woo

Published online: 24 Apr 2018 (Vol.72, No.1, 2018)

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README.md

Data organization in spreadsheets

Slides for a talk for the OSGA Webinar Series, on 24 Sept 2021, based on my paper of the same title with Kara Woo. Also see the related website.

PDF of slides: https://kbroman.org/Talk_DataOrg/dataorg.pdf

PDF of slides with notes: https://kbroman.org/Talk_DataOrg/dataorg_notes.pdf

Video of presentation: https://youtu.be/t74E0a90gkA

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PUBLIC DOMAIN

Homework week 3

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Identify a dataset for the capstone project

- A dataset from your own research
- A dataset from your work
- A dataset that you find interesting and is available as open data

Homework due dates

- All material on course website
- Homework assignment & learning reflection due: **2025-06-20**

Thanks! 

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Slides created via revealjs and Quarto: https://quarto.org/docs/presentations/revealjs/

Access slides as PDF on GitHub