

Data Analysis in Biology

BIO144
FS 2025

Today . . .

- Introduction to the course
- A bit about AI assistants
- RStudio server
- You collect some data
- Review useful knowledge

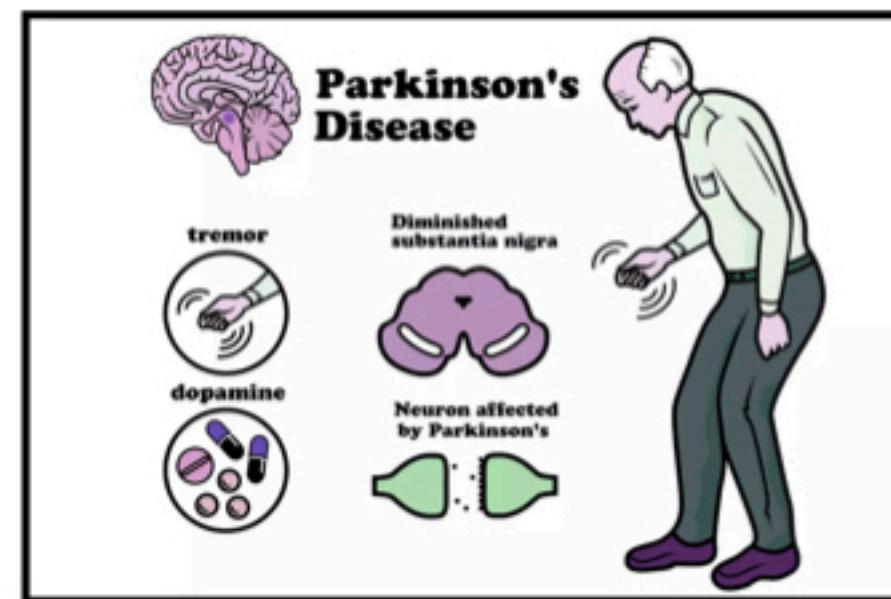


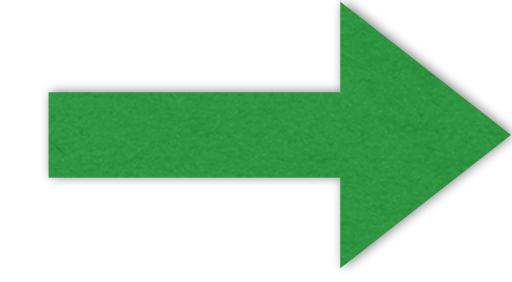
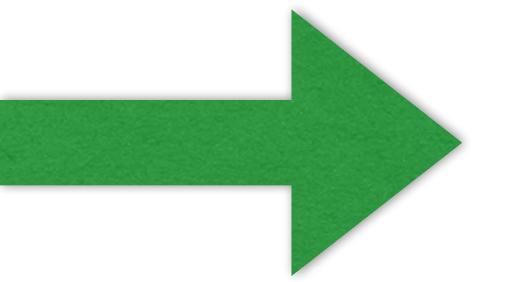


Overarching goals of the course

- ▶ Provide a **solid foundation** for answering biological questions with quantitative data.
- ▶ Help students to understand the **language of a statistician**.
- ▶ Ability to understand and interpret results **in research articles**.
- ▶ Give the students a **challenging, engaging, and enjoyable** learning experience.

Questions you'll work on...





Question
Puzzle
Problem

Data
+
Analysis

Answer
Solution

But how?
What words would you use to describe a
high quality data analysis?

\bar{x} -mean, "sd"

reproducible

objective

robust

efficient

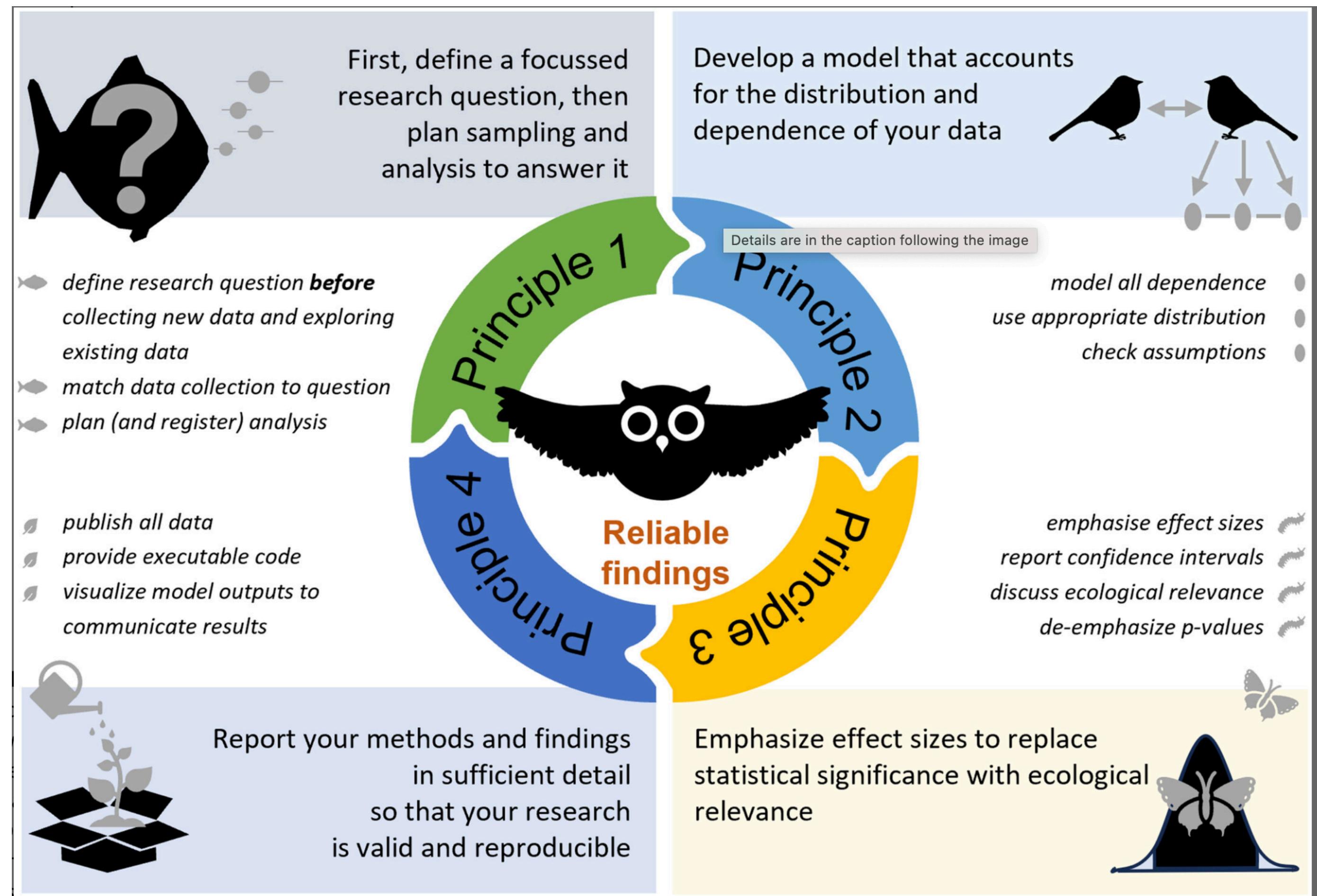
reliable

understandable

significant

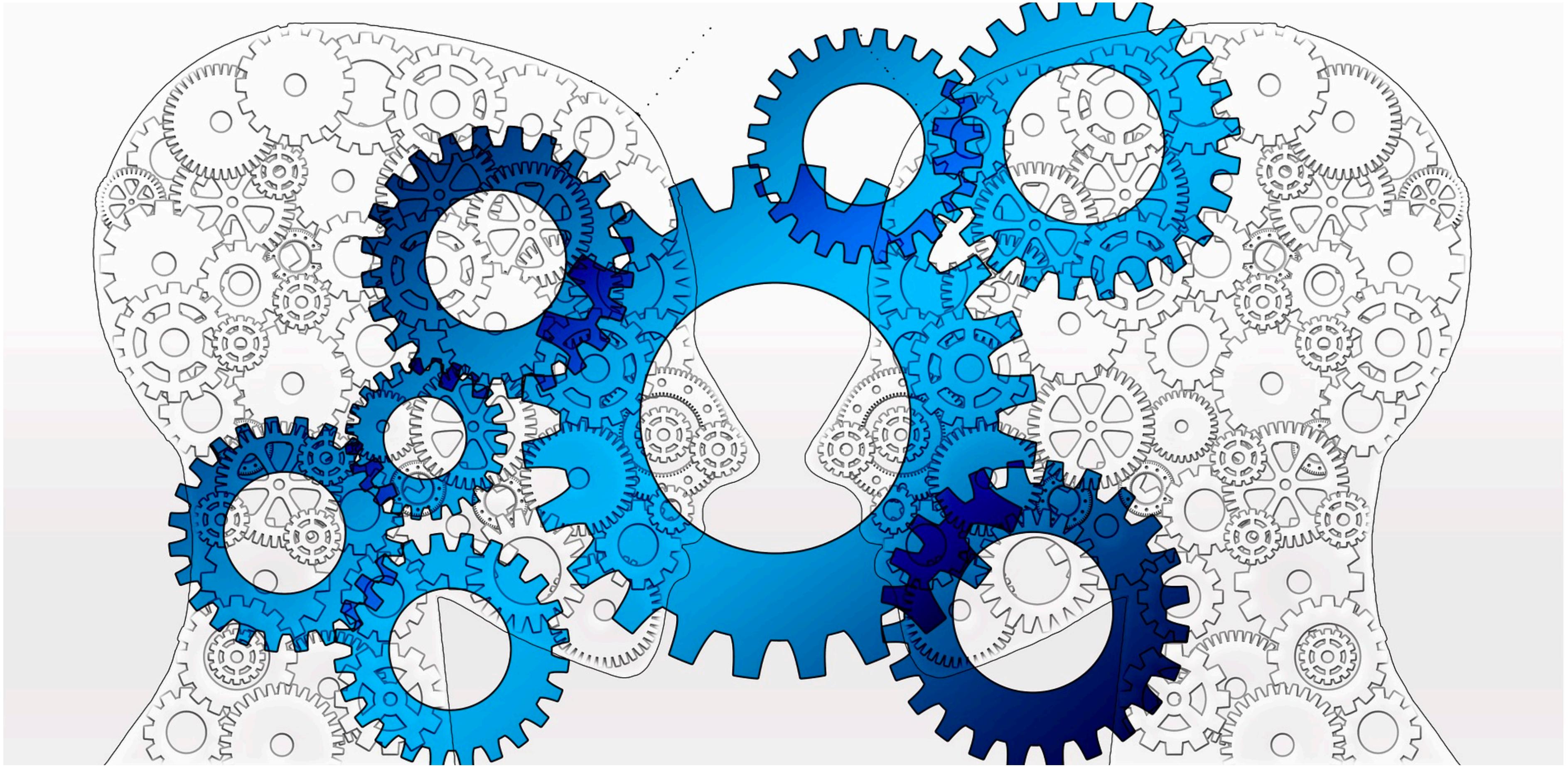
Sharable

fun



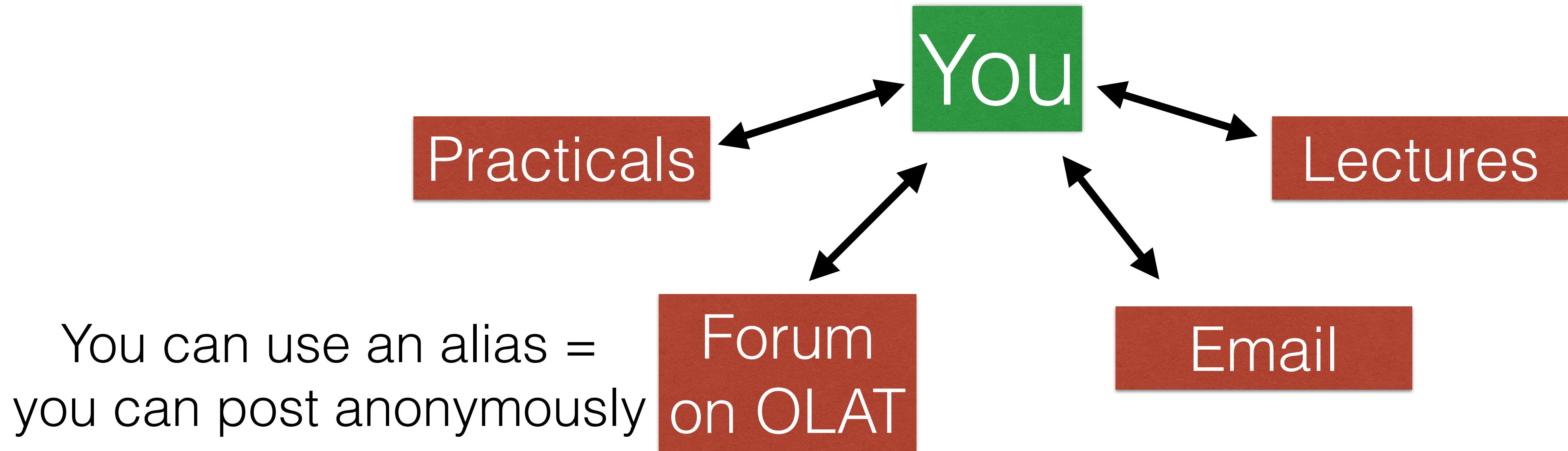
Popovic, G., Mason, T.J., Drobniak, S.M., Marques, T.A., Potts, J., Joo, R., et al. (2024). Four principles for improved statistical ecology. *Methods in Ecology and Evolution*, 15, 266-281.





How the course is organised

The team



Dr Erik Willems
Instructor



Prof. Owen Petchey
Director
Instructor



Martina Jelic
Head Teaching Assistant

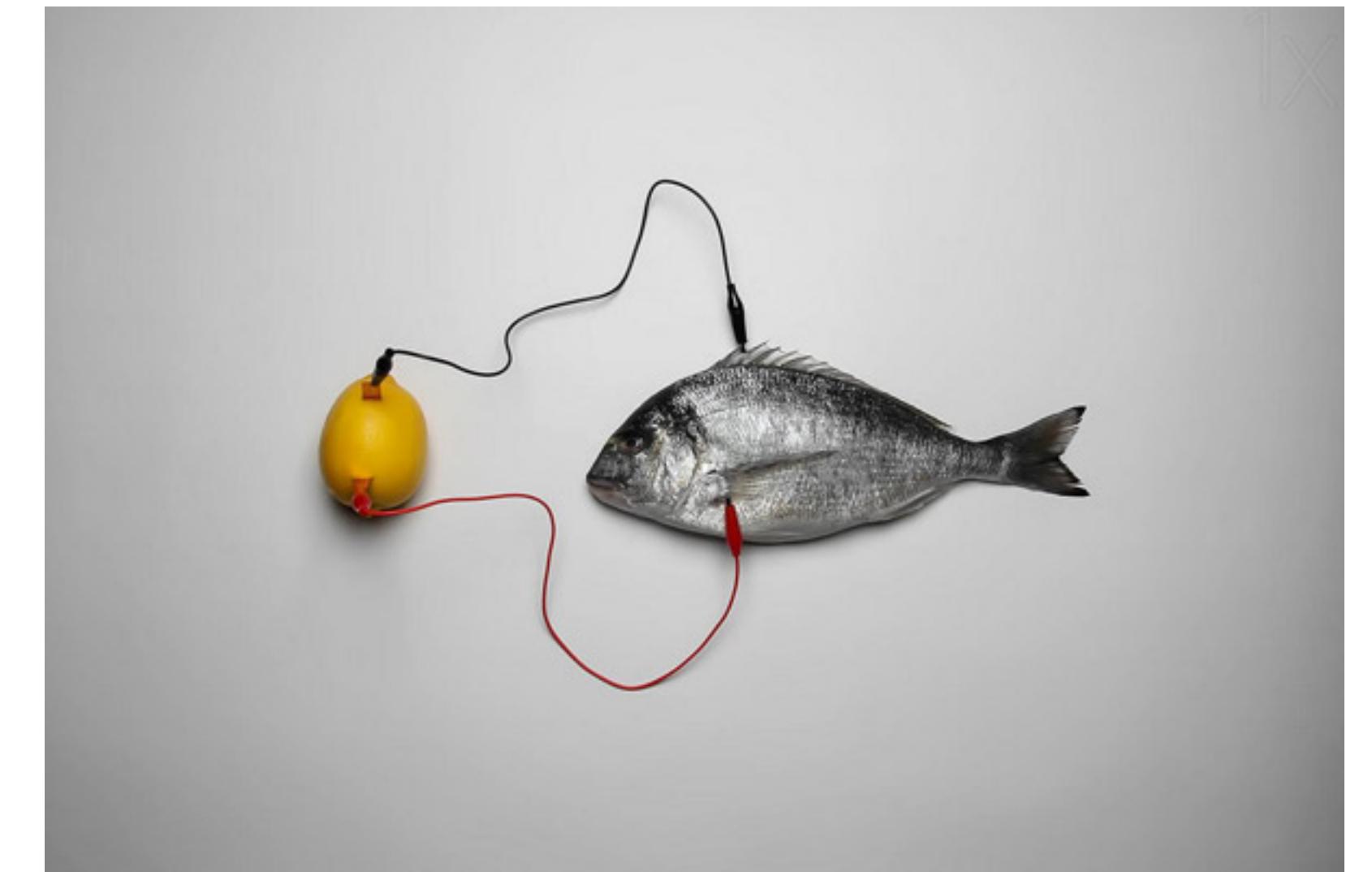


Dr Frank Pennekamp
Examinations

Numerous
teaching
assistants

Units 1 and 2 - Introduction; all about data	2
Unit 3 - Linear Regression Part 1	2
Unit 4 - Linear regression part 2, and multiple regresion	3
Unit 5 - Binary/categorical explanatory variables, and interactions	3
Unit 6 - ANOVA	4
Unit 7 - ANCOVA & Matrix alegbra	4
Unit 8 - Model selection	4
Unit 9 - Interpretation, causality, and cautionary notes	5
Unit 10 - Analysing count data	5
Unit 11 - Analysing binary data	5
Unit 12 - Measurement error; repeated measures and random effects; recap and outlook	6

The conceptual side



1 - 2:45pm Mondays

Lectures 3-6

- No powerpoint slides.
- The “course book” contains what you need to know.
- I will talk, draw, code, and ask questions (think, pair, share).
- Lectures 7-12 usually with slides.

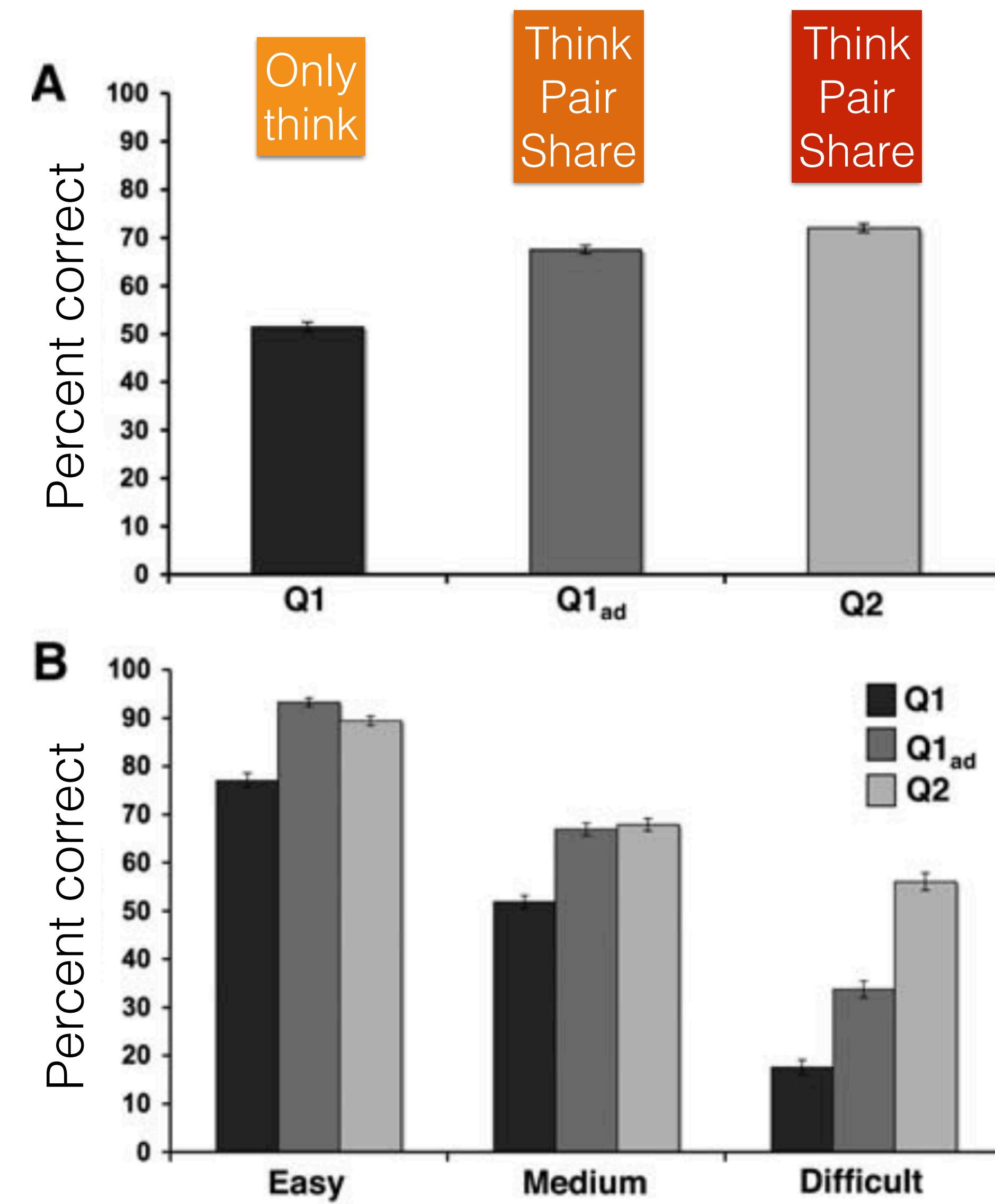


Think, Pair, Share



Think, Pair, Share

Our results indicate that peer discussion enhances understanding, even when none of the students in a discussion group originally knows the correct answer.



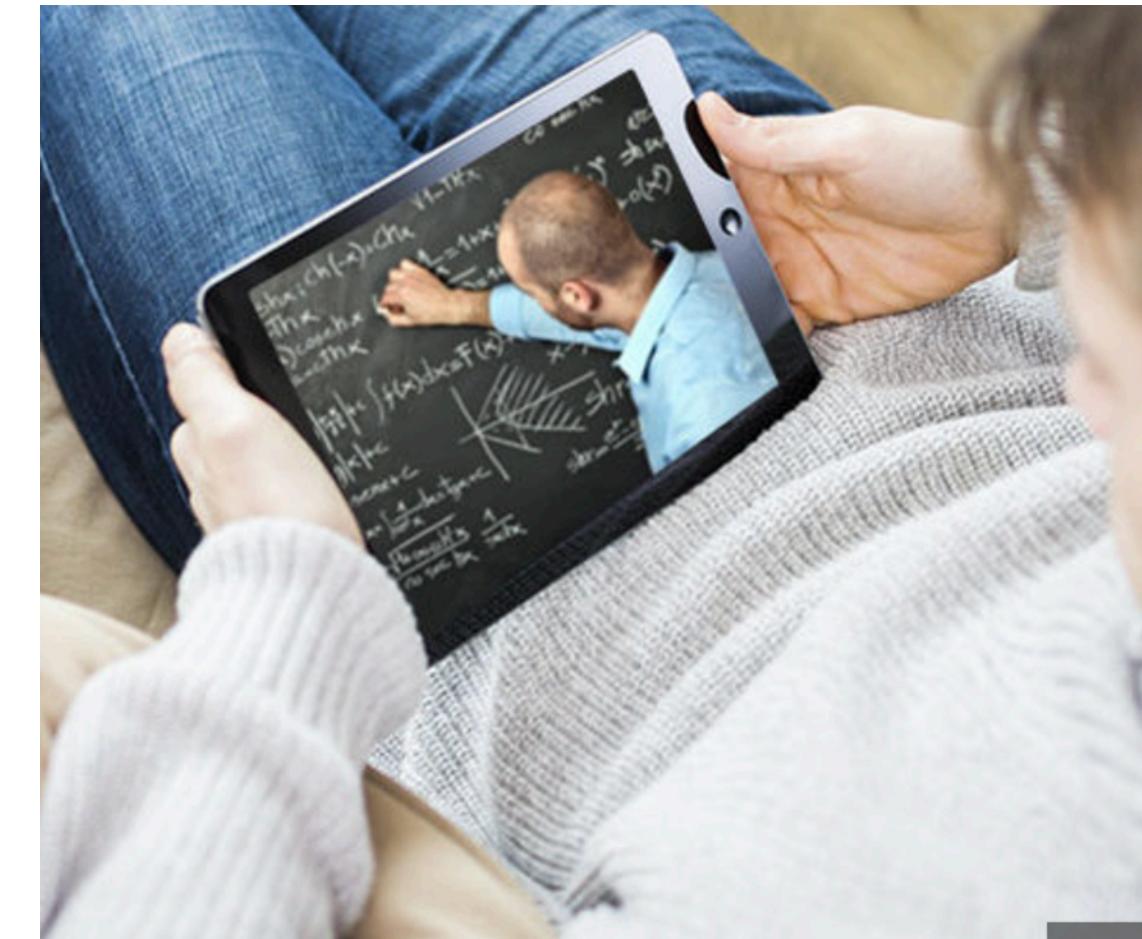
Smith, M.K., Wood, W.B., Adams, W.K., Wieman, C., Knight, J.K., Guild, N. & Su, T.T. (2009). Why Peer Discussion Improves Student Performance on In-Class Concept Questions. *Science*, 323, 122–124.

The practical side



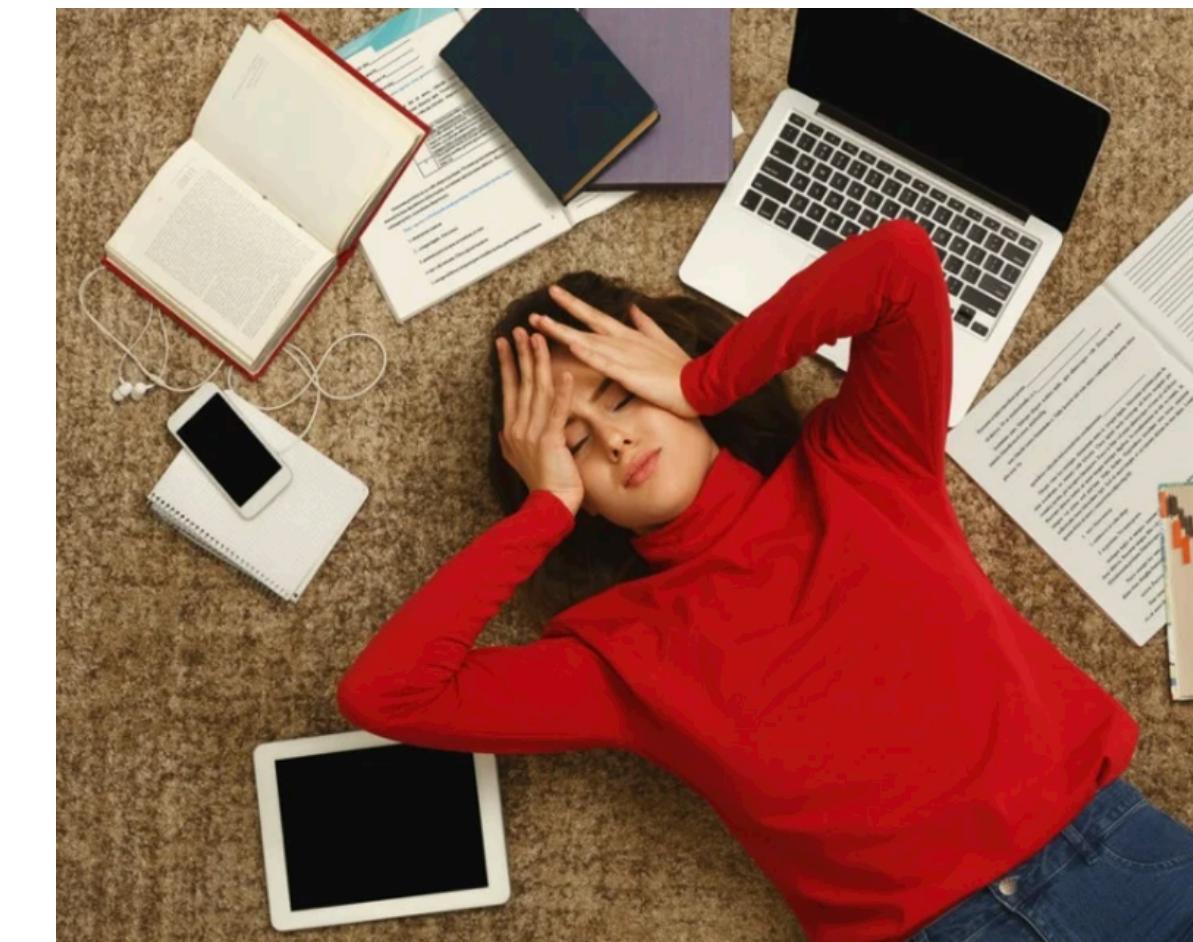
1 - 3pm Thurs. or Fri.

Homework



Sometime between Monday and Thursday/Friday

Weekly practice quizzes



Anytime you like, but we'll get in touch
if you seem to fall behind

The final examination

- It will involve three or four case-studies in which you have to analyses data and answer questions about it. Embedded in the case studies are numerous conceptual questions.
- Quite a lot of the questions require you to answer by entering numbers that are rounded to the required number of decimal places.
- It will be in-person, on-site, and on your own computers (BYOD exam).
- You may bring notes on both sides of one piece of A4 paper. You may not consult any other sources during the exam.
- You will have to use the Safe Exam Browser and RStudio Server.
- You will get access to a representative examination from a previous year.

All of that and more is on OLAT

The screenshot shows the OLAT interface for a course titled "22FS BIO144 Da...". The top navigation bar includes links for Courses, Groups, Authoring, Campus courses, Question bank, and a search bar. The main content area is titled "PREPARATION" and contains a sidebar with course navigation links such as Administration, Status, Course info, Calendar, Participant list, Participant infos, E-Mail, Blog, Wiki, Forum, User role, and My course. Below the sidebar is a list of course units:

- BIO144
- About the course
- Previous knowledge
- Wiki: FAQ
- Forum
- Unit 01
- Unit 02
- Unit 03
- Unit 04
- Unit 05
- Unit 06
- Unit 07

On the right side of the preparation page, there is a list of course-related topics:

- Aims and learning outcome
- Course schedule
- Preparing for the course
- Expected workload
- Bring your own laptop
- What to do each week
- Course texts
- Getting datasets
- Attendance

Learning objectives
Schedule
Weekly structure / activities
Assessment
Getting help
Giving feedback
Attendance
Etc...

"Failure is an opportunity to grow"

GROWTH MINDSET

"I can learn to do anything I want"

"Challenges help me to grow"

"My effort and attitude determine my abilities"

"Feedback is constructive"

"I am inspired by the success of others"

"I like to try new things"

Equip you with the knowledge of how to learn more.

And the confidence that you can.

I may be a professor, but I'm also human.
Feel free to address me as you feel comfortable,
Professor Petchey or Owen
(Probably not "dude" or "mate"!)







The screenshot shows the OLAT course interface for '22FS BIO144 Data Analysis in Biology (Preparation)'. The left sidebar contains navigation links for 'BIO144', 'About the course', 'Previous knowledge', 'Wiki: FAQ', 'Forum', 'Unit 01' through 'Unit 05'. The main content area displays the 'Overview of topics' forum with 3 entries. The first entry is a sticky topic titled 'Sticky: Hyperlinks in OLAT' by Daugaard, Uriah, last modified on 10/29/2021, 10:20 PM. The second entry is a sticky topic titled 'Sticky: Guidelines for posting code in the forum (read before posting)' by Daugaard, Uriah, last modified on 9/15/2021, 5:08 PM. The third entry is a sticky topic titled 'Sticky: What is this Discussion Forum for? (read before posting)' by Daugaard, Uriah, last modified on 9/15/2021, 4:52 PM. A large black arrow points upwards from the bottom of the page towards the sticky topics in the forum list.

Courses Groups Authoring Campus courses Question bank 22FS BIO144 Da... X

Course info Calendar Participant list Participant infos E-Mail Blog Wiki Forum Documents Glossary User role My course

Course chat Course search

BIO144

► About the course

► Previous knowledge

Wiki: FAQ

Forum

► Unit 01

► Unit 02

► Unit 03

► Unit 04

► Unit 05

Overview of topics

Open new topic Archive forum

Search

3 Entries

Type	Discussion topics	Author	Last modified	Marked	New	Posts
Sticky	Hyperlinks in OLAT	Daugaard, Uriah	10/29/2021, 10:20 PM	0	0	1
Sticky	Guidelines for posting code in the forum (read before posting)	Daugaard, Uriah	9/15/2021, 5:08 PM	0	0	1
Sticky	What is this Discussion Forum for? (read before posting)	Daugaard, Uriah	9/15/2021, 4:52 PM	0	0	1

Ask questions / make requests here.



AI Assistants

The screenshot shows a journal article page. At the top, it says "Methods in Ecology and Evolution" and "BRITISH ECOLOGICAL SOCIETY". Below that, there are links for "FORUM", "Open Access", and "CC BY". The main title of the article is "Should we still teach or learn coding? A postgraduate student perspective on the use of large language models for coding in ecology and evolution". Under the title, it says "This article relates to: ▾". The authors listed are Heather Campbell, Thomas Bluck, Ella Curry, Derrick Harris, Billie Pike, and Bethany Wright. The publication date is "First published: 01 October 2024 | <https://doi.org/10.1111/2041-210X.14396>". Below the article, it says "University of Zurich" and "Handling Editor: Robert B. O'Hara".



“ I always found if I'm trying to research something I just go around websites and pages skipping through and in the end, I've gone around in circles. So that's helpful [about LLMs]. ”

“ It's really helpful with coding for checking what you're doing, but other than that, I haven't used it for anything else. I think it cuts out what I see as important parts of the process of doing a lot of things. If I just ask it something and it gives the answer, then I haven't gone through that process of researching, exploring, and interpreting it myself. ”

“ I've had it get things wrong, for example when I couldn't work out which package I'd used I gave ChatGPT my code and requested it identify the package used for a specific section out of the listed packages I had installed. The response suggested three different packages, none of which I had used. When told these packages were not applicable, ChatGPT acknowledged it was wrong but would not provide an alternative answer. ”

Methods in Ecology and Evolution



FORUM | [Open Access](#) | [CC BY](#)

ChatGPT is likely reducing opportunity for support, friendship and learned kindness in research

[This article relates to:](#) ▾

Joseph Millard , Alec P. Christie, Lynn V. Dicks, Justin E. Isip, Thomas F. Johnson, Grace Skinner, Rebecca Spake



Cooper et al. (2024) write that ‘students may be happier to ask chatbots for help than to ask a human instructor, out of fear that the latter will judge them harshly for not knowing the answers to simple questions’. Sadly, this is likely true for many students.

Ask for help understanding...

- What is the mode of a distribution?
- I didn't understand that explanation. Can you give a more easily understood explanation?
- Can you show me the mode graphically?
- Can you please give me an example of getting the mode of a distribution in R?

Ask for help writing code...

- Please use functions from the tidyverse package to write R code.
- Please try to not use square brackets or dollar signs.
- Please write code that will import data, give number of missing values in each variable, and graph all pairwise relationships.
- Please write code that will import a dataset containing two continuous variables, perform linear regression, check model diagnostics, give a summary of the linear regression results, and make a nice visualization including the regression equation, the explanatory power, and the p-value of the slope, the regression line and the confidence and prediction interval around the fitted regression line.

What can I use an AI assistant for in BIO144?

Think, Pair, Share



Your relationship with AI Assistants

In a strong AI-developer relationship, the AI serves as an empowering tool—a knowledgeable collaborator that complements the developer's skills, accelerates their workflow, and supports their growth as a coder. The developer, in turn, provides context, direction, and critical judgment to extract the maximum value from the AI's capabilities.

In a poor relationship, the developer uses the AI's output without understanding it, leading to bugs, inefficiencies, or misaligned solutions. The developer becomes overly reliant on the AI, copying and pasting solutions without understanding them, which leads to long-term skill stagnation. The developer uses the AI's output without understanding it, leading to bugs, inefficiencies, or misaligned solutions.

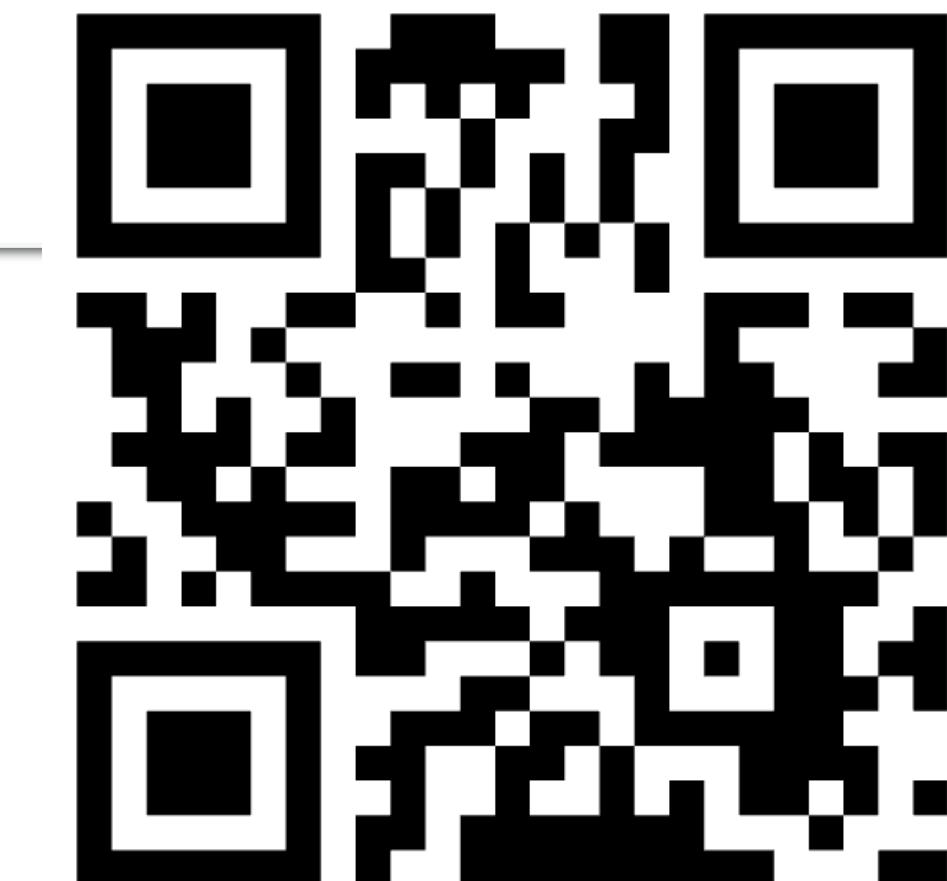
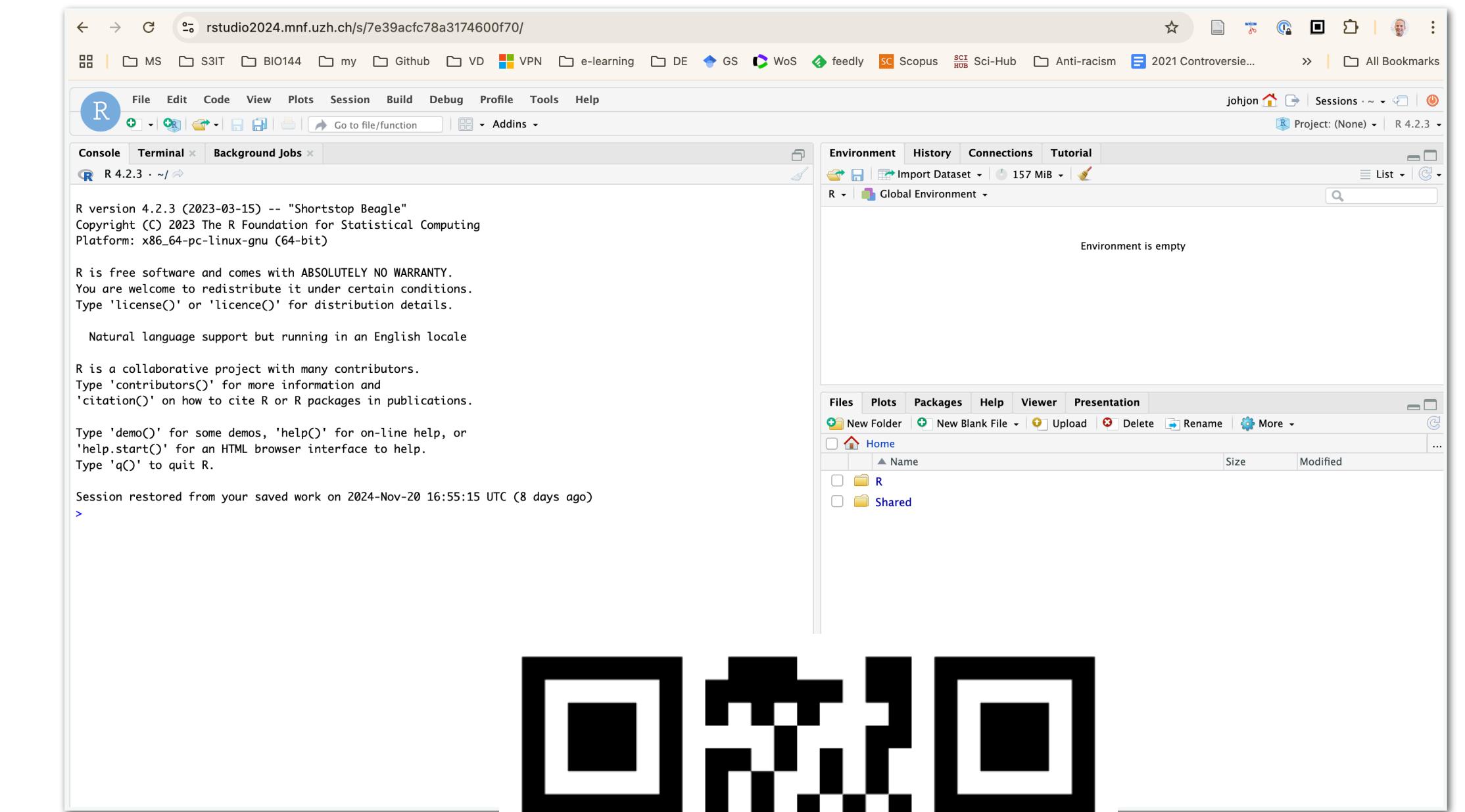
I suggest you try to minimize their use during the course.
(Also try to minimize using the example solutions.)

**Do the work, get the benefit.
(the knowledge and expertise that you contribute to a
good relationship with an AI assistant).**

RStudio Server

You can use RStudio in a web browser
—you use an RStudio Server

- **Bad thing:** You have to be connected to the internet
- **Good thing:** Lots of the setup is already done for you
- **(Good thing:** available memory and CPUs can scale)
- **Requirement:** you will have to use RStudio server in the exam.



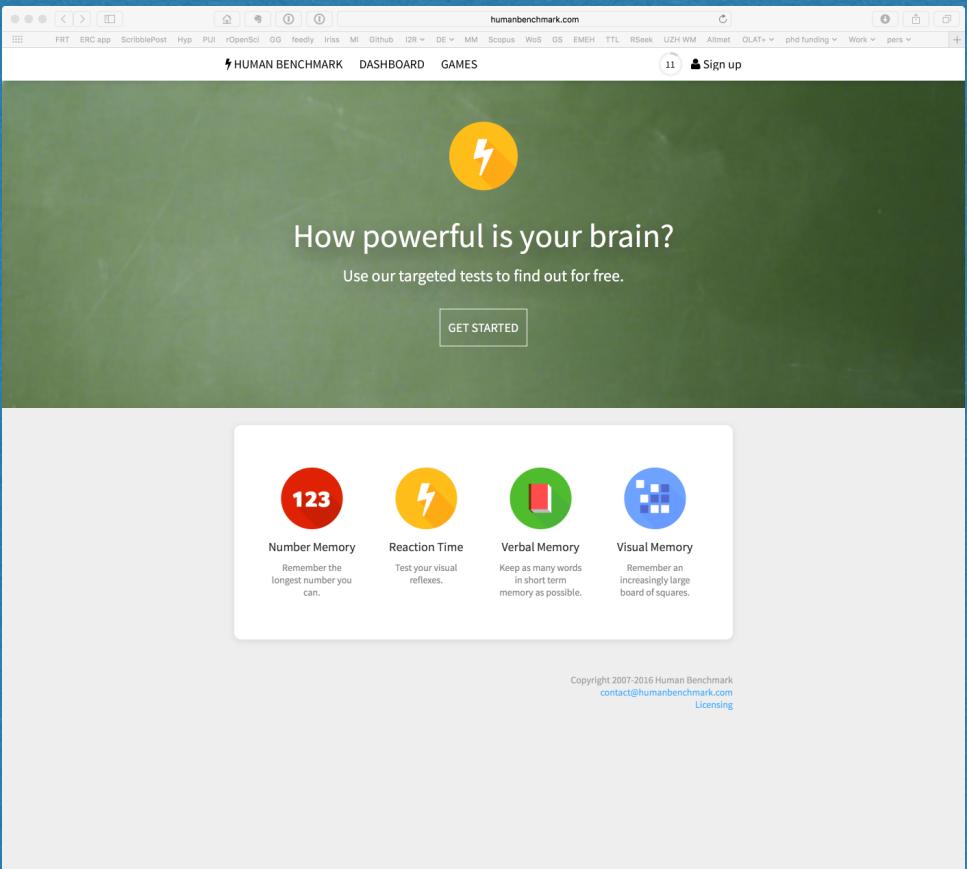
<https://rstudio2024.mnf.uzh.ch/>

We need some data to work with...

Do some tests and record the resulting data

Do the tests here

humanbenchmark.com



Record the results here

My Human Benchmark results
For live data analysis demonstration, BIO144, Data Analysis in Biology
*Required

Please enter the unique ID code you gave yourself. *

Your answer _____

What is your gender? *

Female
 Male
 Other: _____

Please enter your average reaction time in seconds (e.g., 0.326). *

Your answer _____

Please enter your score on the Verbal Memory test. *

Your answer _____

Please enter your score on the Number Memory test

Your answer _____

Please enter your score on the Visual Memory test.

Your answer _____

SUBMIT

Never submit passwords through Google Forms.



Link is also in a Forum post on OLAT

Activate your prior learning!

22FS BIO144 Datenanaly

- About the course
- Previous knowledge
 - Introduction
 - Notation review
 - Self-tests
 - Getting R & RStudio
 - Getting to know R
 - Help about R and RS
 - What are add-on pac
- Wiki: FAQ
- Forum
 - Unit 01
 - Unit 02
 - Unit 03
 - Unit 04
 - Unit 05

Introduction

The aims for this section are:

1. To help you know about your knowledge of some of the things you should already know before you start BIO144.
2. To give you a chance to refresh your knowledge about some of the things you don't recall so well.
3. **Important:** Multiple choice questions with little squares in which you need to tick the correct answers can have any number of correct answers. Such questions with little circles have only one correct answer. (See the illustrative examples in the next page.)

Please note that the things covered in this section are not exhaustive, i.e. there might be other things you've previously learned about useful for BIO144.

Your score in the quizzes here doesn't contribute to anything. It's just for you!

Notation review

Self-tests

Getting R & RStudio

Getting to know R

Help about R and RStudio

How to get help about R and RStudio

What are add-on packages?

Use the resources on OLAT

You should have already done this.
If you have not, you still have time

Reviewing what you already experienced / what would be useful for you to already know

Summarising distributions of data

Central tendency: mean, median, mode

Measures of spread: range, quartiles, standard deviation, standard error

Symmetry: skew.

Pointy-ness: kurtosis.

Number of peaks: unimodal, bimodal, multimodal

Statistics:

Expected value

Parameter

Parameter estimate

Variable

Central limit theorem

Hypothesis testing

Degrees of freedom

P-value

Notation

\bar{x} ("x bar")

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$$

Types of variable:

numeric, continuous, discrete, categorical, dependent/response, independent/explanatory.

T-test

Linear regression



Difference between a *population* and a *sample*.

Probability: e.g., what is the probability of getting five heads if we toss a fair coin seven times?

Probability distributions: normal, binomial, poisson, exponential.

Frequency distributions, aka, histograms.

Visualisations: box and whisker, scatterplots.

Models of relationships: equation for a straight line.

Live data analysis demonstration

BIO144
Week 1

Its a demonstration...

The idea is to give you a feel of what is involved in data analysis.

You will understand some of the demonstration.

You will not understand some of it.

Keep notes about what you don't understand.

Live data analysis demonstration

The whole data analysis workflow in one hour!!!

Question

Expectation

Planned presentation & analysis

Selection of subjects

How will data be collected?

Ethics / permissions

Data collection

Data wrangling

Visualise

Statistical test

Critical thinking

Report / communicate

Live data analysis demonstration

The whole data analysis workflow in one hour!!!

Question

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The question

- What should be our question?
- As always, there are some influences and some constraints.
- We should ask a question of interest to us, and of some importance.
- And we should be able to collect the data, within our current constraints, necessary to answer the question.
- The question we will address is "***do male and female reaction times of students at the University of Zurich differ?***".
- Why this question? Reaction times are important, safety, sport...

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Expectation

- Quite a lot of work on this already.
- Generally, males tend to have faster reaction times than females. So we expect that to be the same for students at the University of Zurich.
- Given that you know this pattern, and you are the subjects, its interesting to see if you women can buck the trend, perhaps by trying especially hard. Though now the men know you might do this, it probably won't work!

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What graph?

Live data analysis demonstration

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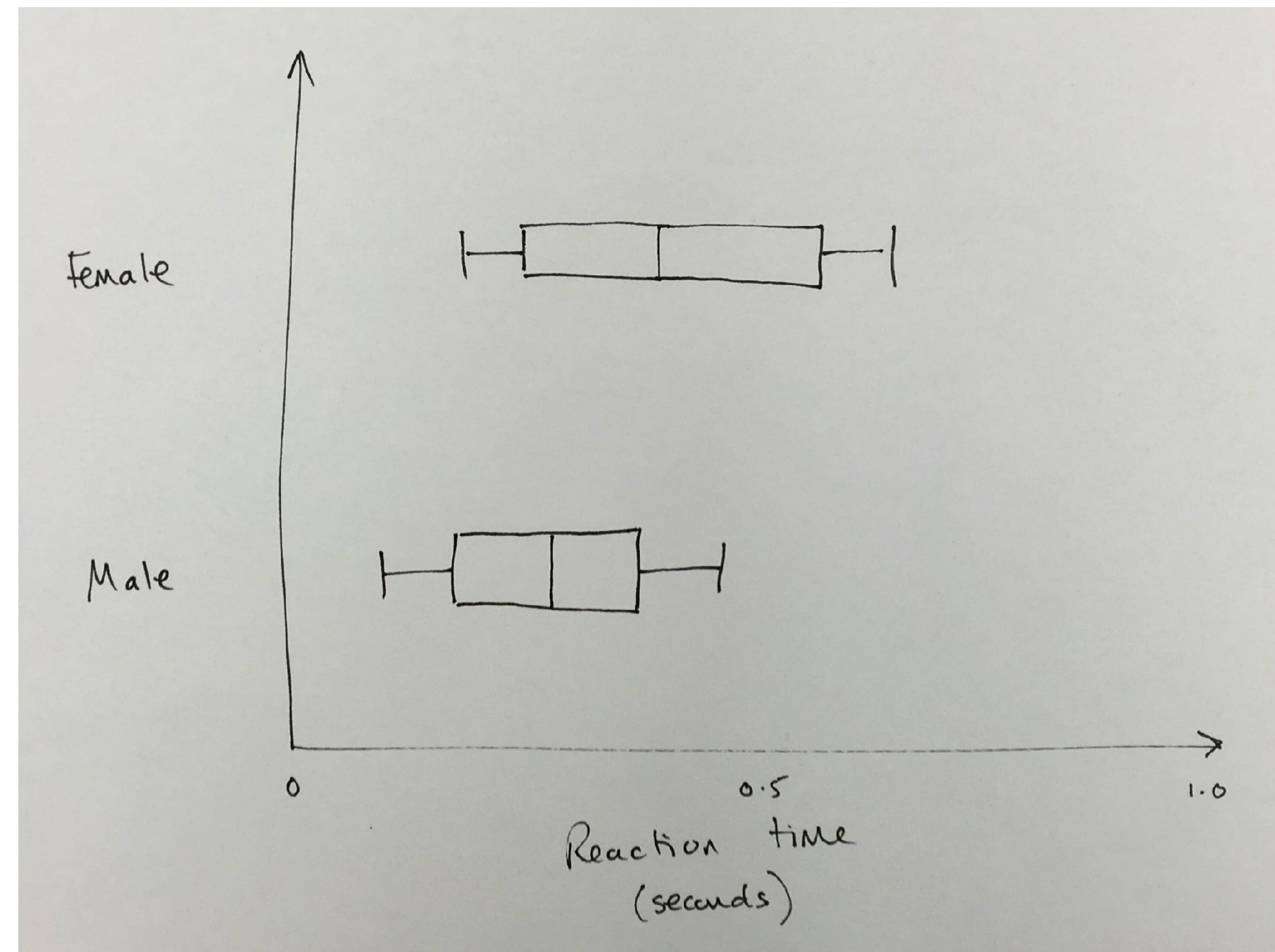
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What statistical test?
What assumptions?

Live data analysis demonstration

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Make up a unique ID code for yourself.
It should not be anything that could identify you.
Keep it safe.

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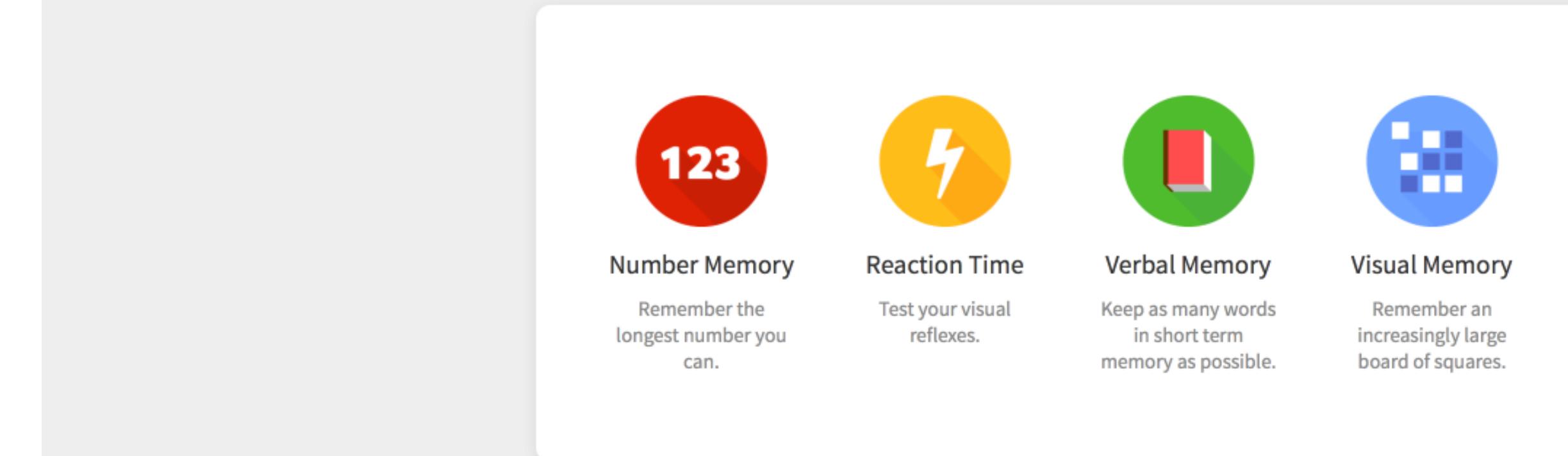
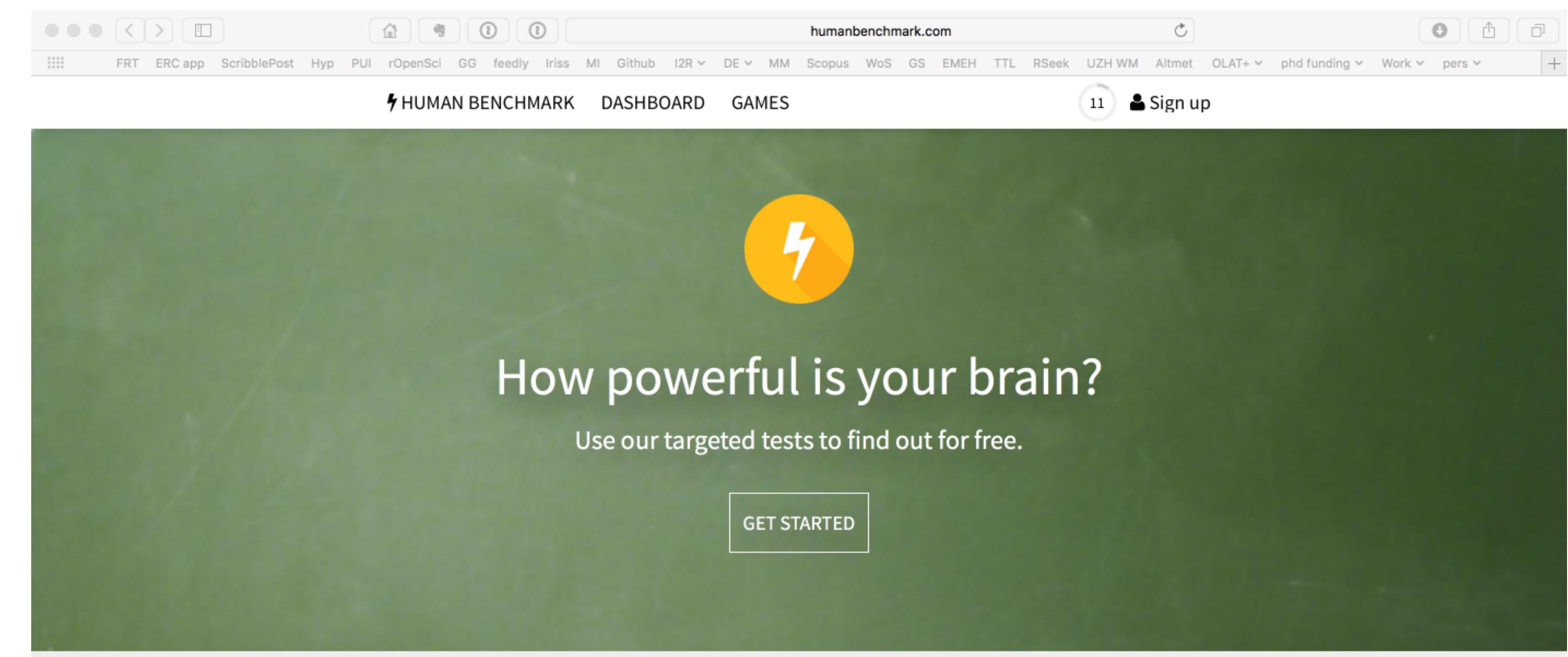
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humanbenchmark.com



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<https://forms.gle/o9kJh9dBjbJHXCTv6>

Link is also in a Forum post on OLAT

The screenshot shows a Google Forms survey titled "My Human Benchmark results". The survey is intended for a live data analysis demonstration, specifically for BIO144, Data Analysis in Biology. It includes fields for entering a unique ID code, gender (Female, Male, Other), average reaction time in seconds, verbal memory score, and number memory score. The survey is currently empty, showing placeholder text for each question.

My Human Benchmark results

For live data analysis demonstration, BIO144, Data Analysis in Biology

*Required

Please enter the unique ID code you gave yourself. *

Your answer

What is your gender? *

Female

Male

Other:

Please enter your average reaction time in seconds (e.g., 0.326). *

Your answer

Please enter your score on the Verbal Memory test. *

Your answer

Please enter your score on the Number Memory test



Live data analysis demonstration

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Check the data in the spreadsheet

(The hyperlink might only work for Owen.)

\bar{x} -mean, "sd"

reproducible

objective

robust

efficient

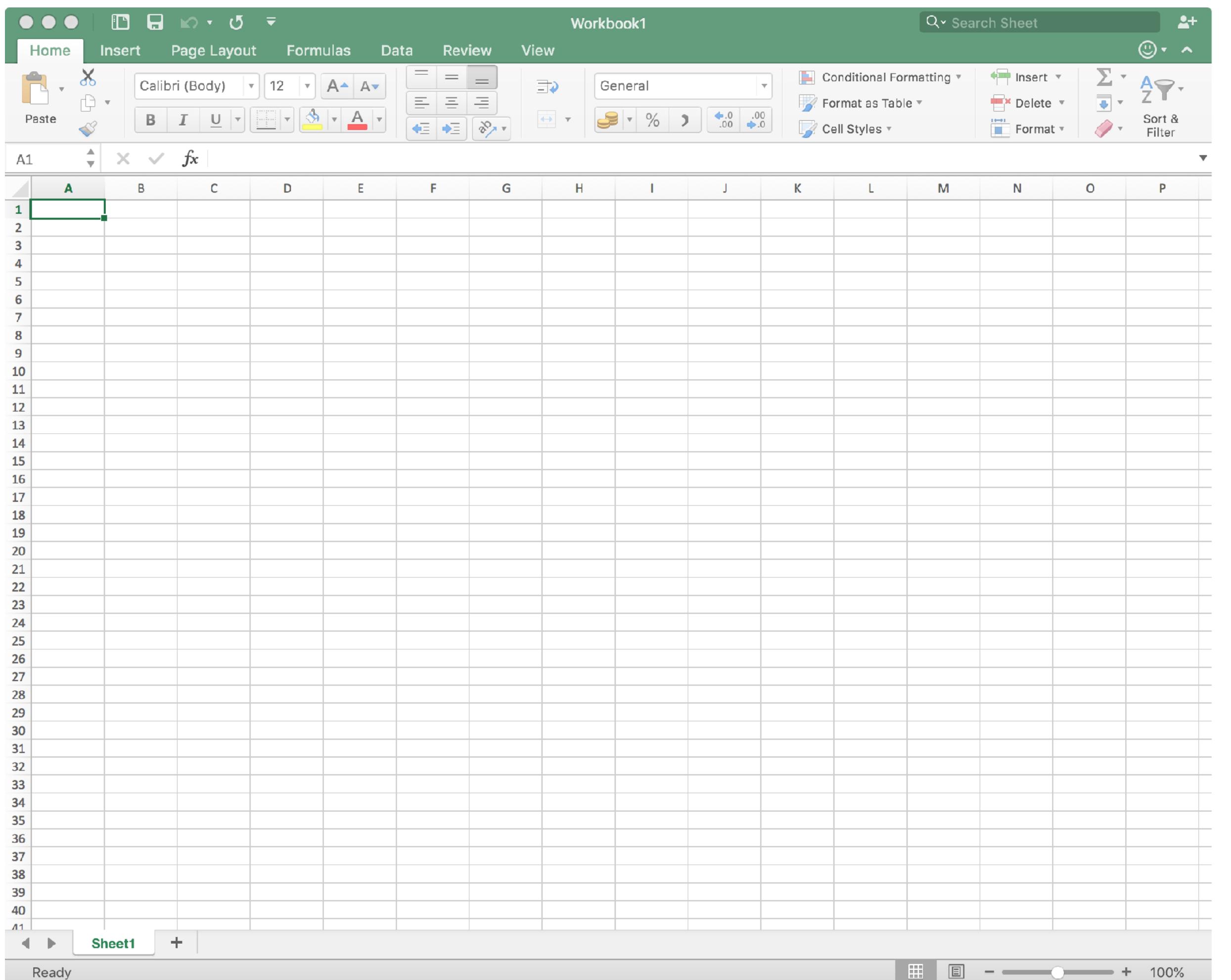
reliable

understandable

significant

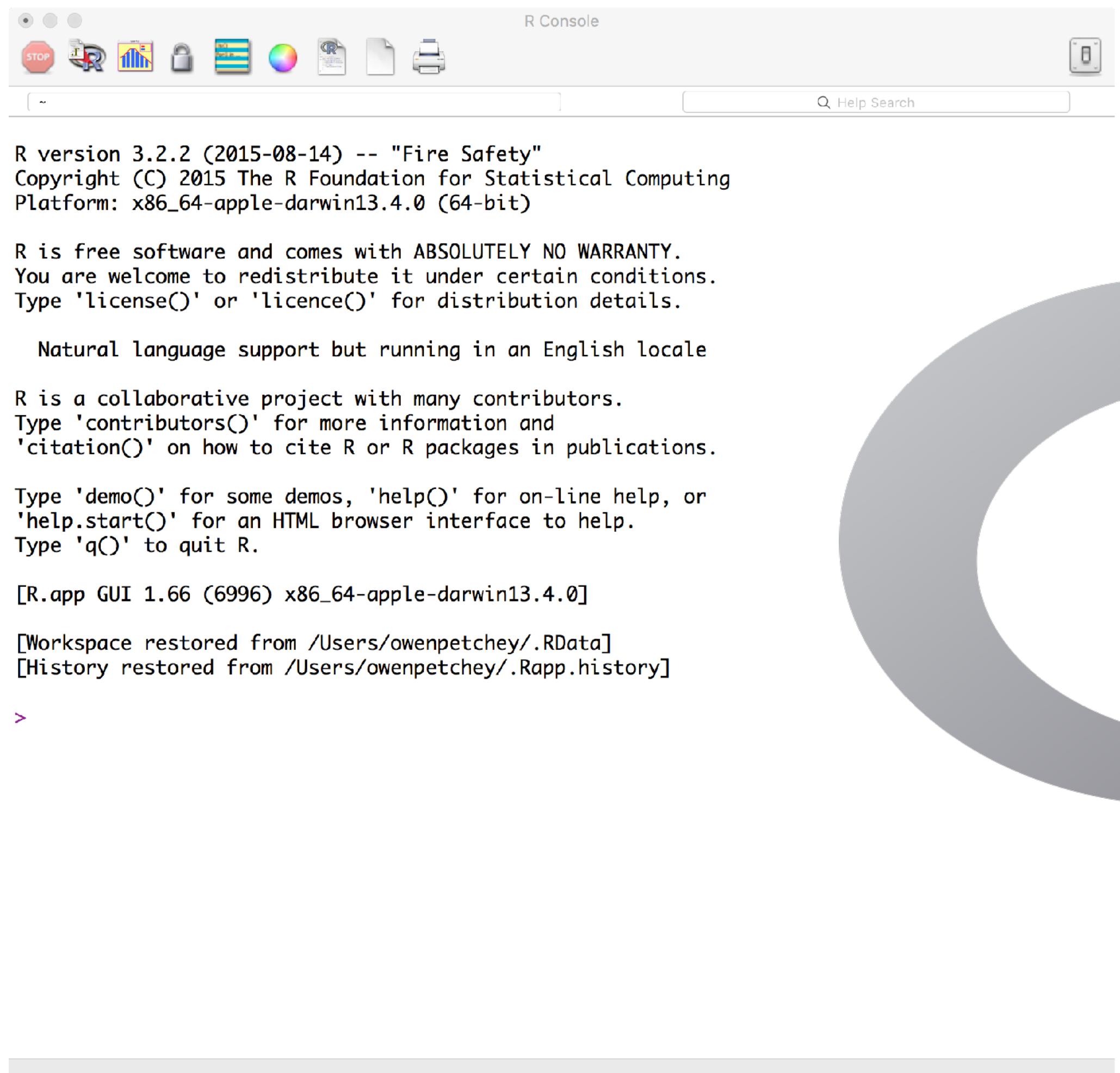
Sharable

fun



Efficient
Consistent
Repeatable
Reliable
Readable
Robust
Persistent
Sharable
Scalable

Efficient
Consistent
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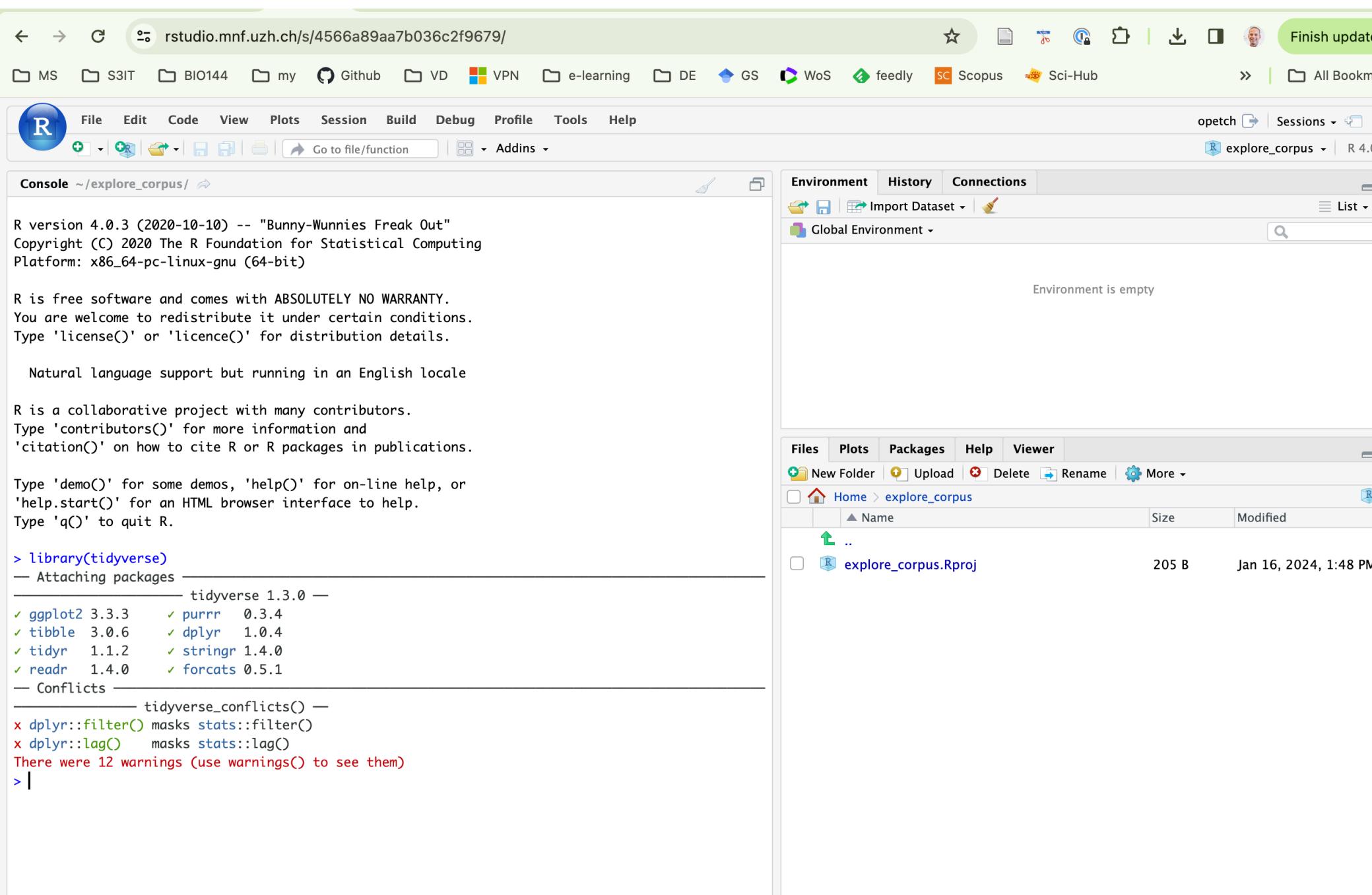


Some computers have great trouble installing and running R / Rstudio

If this seems to be you, then quickly switch to

RStudio Cloud

Ask a TA about this in the first practical



Live data analysis demonstration

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Live in RStudio

With the help of ChatGPT

Live data analysis demonstration

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With the help of ChatGPT

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