Programming for psychologists

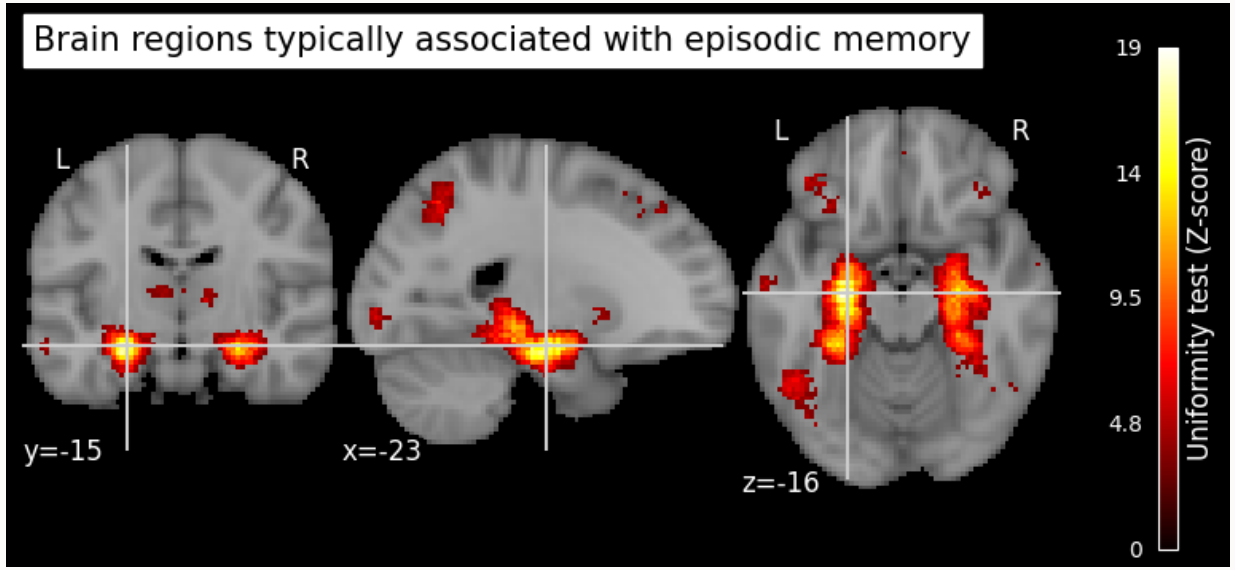
Lecture 7: Recap & workflow

Matthias Nau

Home assignment

Home assignment

- **Due on December 19th, 6pm**
- **Pursue a new project from scratch** to visualize MRI data, including setting up a conda environment, writing code, and uploading it to GitHub for version control and pull requests.
- **Full description on Canvas** under the "Home assignment" module
- **Questions?**



Exam preparation

Exam – Organizational matters

- The exam will take place on **December 16th, 8:30-11:30pm in NU-3A06.**
- It will be written in **TestVision**; the standard application at the VU for digital exams
- You are going to get a **computer/laptop by the VU** for the exam.
- **No internet access** during the exam.

I will send out an email closer to

the date with detailed information.

Exam – Content

- **Multiple choice and multiple answer questions.**

  You will not know how many answers are correct and need to think about each one.

- **Conceptual questions:** Check out the last slide of each lecture again!

Example: What is GitHub CoPilot?

- ❑ A browser exension for reviewing pull requests
- ❑ A GitHub feature to resolve merge conflicts
- ☑ An AI-powered tool that suggests code in VScode
- ❑ An online bot managing your GitHub repositories

Exam – Content

- **Multiple choice and multiple answer questions.**

  You will not know how many answers are correct and need to think about each one.

- **Conceptual questions:** Check out the last slide of each lecture again!

- **Code questions (with screenshot):** Complete the practical notebooks!

Example: What is the output of this code?

- ❑ Sarah
- ✓ ❑ Chris
- ❑ None
- ❑ 5

```
name = "Chris"
if name == "Sarah":
    print(len(name))
elif name == "Chris":
    print(name)
else:
    print("None")
```

Exam – Content

- **Multiple choice and multiple answer questions.**

  You will not know how many answers are correct and need to think about each one.

- **Conceptual questions:** Check out the last slide of each lecture again!

- **Code questions (with screenshot):** Complete the practical notebooks!

- **Documentation question (with screenshot):** Just read carefully!

Example:

What is the default width of the "bar" function?

Exam – Content

- **Multiple choice and multiple answer questions.**

  You will not know how many answers are correct and need to think about each one.

- **Conceptual questions:** Check out the last slide of each lecture again!

- **Code questions (with screenshot):** Complete the practical notebooks!

- **Documentation question (with screenshot):** Just read carefully!

Do not worry, you know more than you think!

What was this course about again?

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- **Understanding the "programming mindset"** → **Lecture 1, practical 1.1**

- Embracing coding as your new superpower.
- Understand how it can help you in your work.

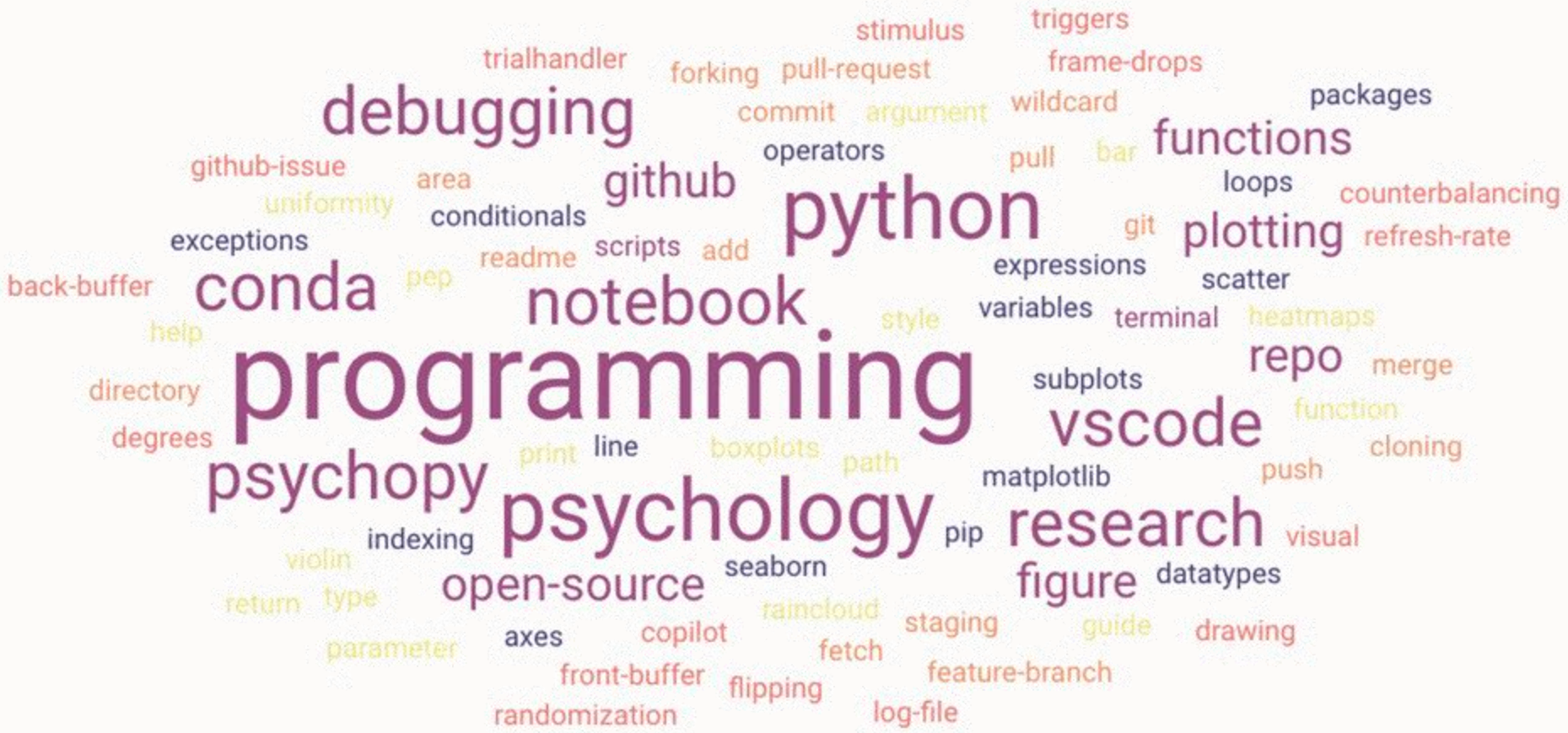
- Thinking of programming as craft that needs practice, continued learning, and creative problem solving.

- Design from the top, implement bottom-up.
- Imperative vs. declarative instructions.

- Let go of the "one right way of doing something".
- Let go of intimidation: Anyone can learn with practice
- Learn to make justifiable decisions & take responsibility

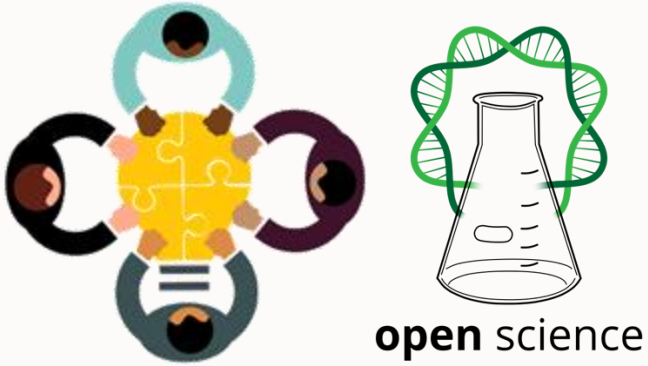
What was this course about again?

- **Understanding the "programming mindset"**
- **Demystifying key terms and concepts** → **Check out last slide of each lecture!**



What was this course about again?

- **Understanding the "programming mindset"**
- **Demystifying key terms and concepts**
- **Internalizing best practices** → **Lecture 6, but really all throughout the course**



- Writing code in the spirit of open science and collaboration
- Testing and documenting code with healthy paranoia

- Version control and collaboration with Git
- Code sharing and code review with GitHub

- Writing functions, working with file paths, basics in code design, PEP8 style guide etc.

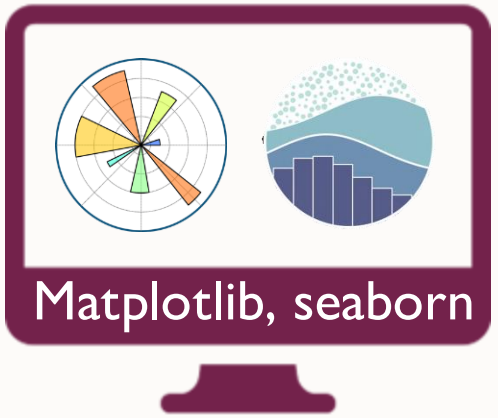
What was this course about again?

- **Understanding the "programming mindset"**
- **Demystifying key terms and concepts**
- **Internalizing best practices**
- **Familiarizing yourself with Python** → **Lectures 2,3,4,6, almost all practicals**

Experiments

Data analysis

Data viz



Stats & Models

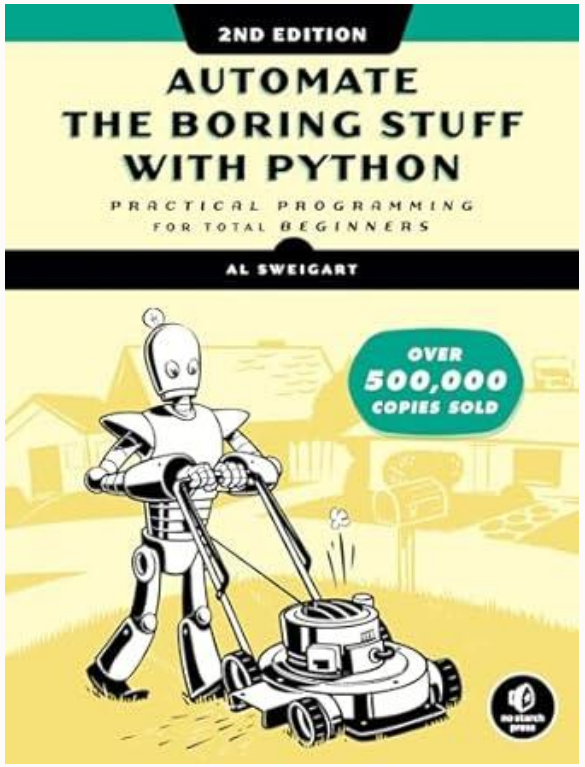
What was this course about again?

- **Understanding the "programming mindset"**
- **Demystifying key terms and concepts**
- **Internalizing best practices**
- **Familiarizing yourself with Python**
- **Learning about tools for continued learning**

Lecture 1,2,4, Practicals

- Debugging strategies help with learning by doing

- Free online resources



The Good Research Code Handbook

This handbook is for grad students, postdocs and PIs who do a lot of programming as part of their research. It will teach you, in a practical manner, how to organize your code so that it is easy to understand and works reliably.

CS50's Introduction to Programming with Python

OpenCourseWare

What was this course about again?

- **Understanding the "programming mindset"**
- **Demystifying key terms and concepts**
- **Internalizing best practices**
- **Familiarizing yourself with Python**
- **Learning about tools for continued learning**
- **Getting to know workflows of a research psychologist**
- Various software tools and associated workflows

- Overview on programming
- Stimulus presentation, log files, triggers, randomization, basic analysis, file paths etc.

Throughout the course!

What was this course about again?

Big Picture

With the right **perspective**, you will learn everything you need to learn through **practice**.

If you are not there yet, don't worry!

- You were not expected to become experts in Python by the end of the course (see Lecture 1)
- Everyone succeeds & struggles in their own way.
- Help us improve the course by giving feedback!

A typical day in the life of a PhD student

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Vs.

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  I should become a scuba-diving instructor!”. Too early for this decision.

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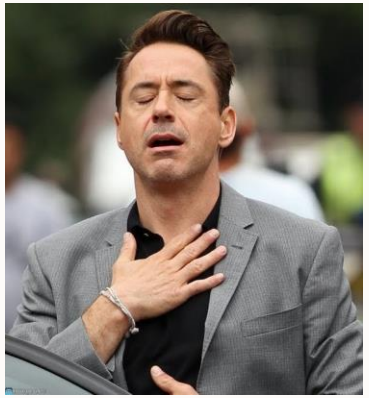

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- **10:00 am**: Experiment starts. 15 mins late, but it’s finally running!

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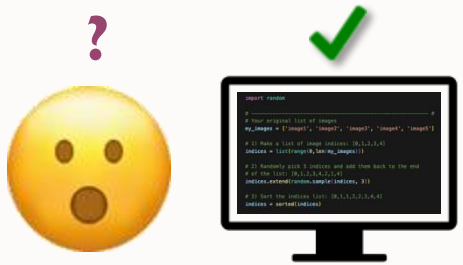

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- **11:50 am**: Still debugging…. Realizing you changed the Pandas column names yesterday.

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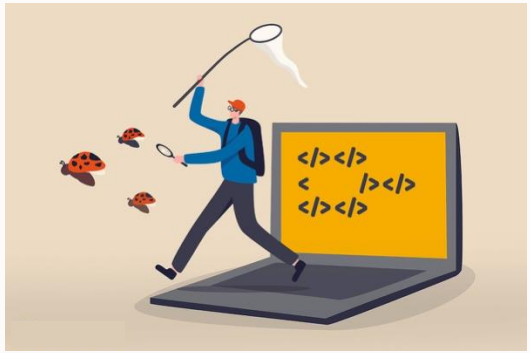

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- **2:15 pm**: 45 mins of debugging later, you figured it out! Some labels were switched in the log file, but that's fine, because all information was there, thanks to redundancies in the log file.
- **3:00 pm**: Meeting with your supervisor. You show the figure and feel super proud.

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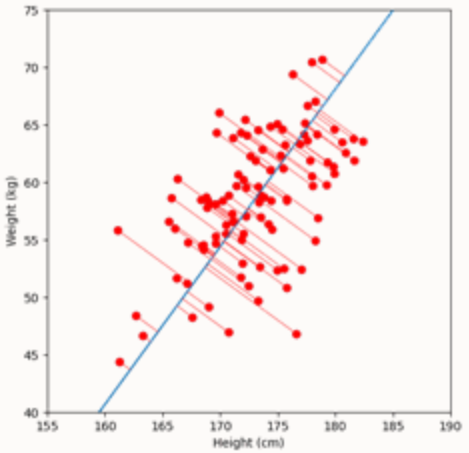
- **4:00 pm:** Trying to implement the analysis you talked about in the meeting.

  You found the relevant Python package, “but what actually is PCA”?



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- **7:30 pm:** Family calling. "How is it going with your thesis writing?".

A typical day in the life of PhD student – Take aways

- **Programming is more than coding and often the first and last thing you do.**
- **The concepts and skills you picked up here will support you in diverse ways.**
- **Your learning has only begun – Come back to these slides later!**
- **Good debugging skills are key! It's a hard start, but it becomes easier.**
- **Implementing best practices will help you built confidence and grow your own helpful code base (e.g., version control)**

Basic statistics in Python

Basic statistics in Python

- Python provides powerful packages to handle **statistical analysis** easily and efficiently.

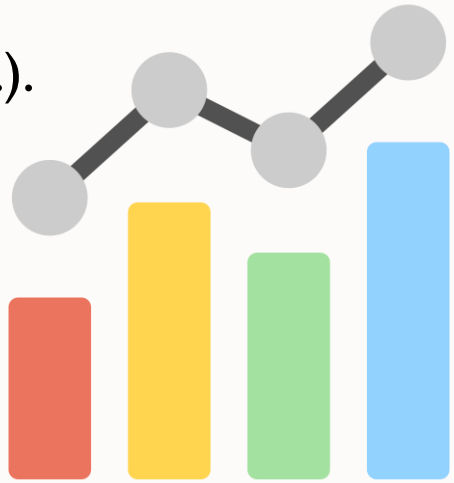
- Common tasks include:
  - **Descriptive statistics** (mean, median, variance, etc.).
  - **Inferential statistics** (t-tests, ANOVA, regression, etc.).
  - **Data visualization** to interpret and present results (Matplotlib, Seaborn, etc.).

Descriptive statistics functions are **often built-in** in other packages

- **Numpy** (e.g., numpy.mean(), numpy.median, numpy.std(), etc.).
- **Pandas**(e.g., df['name'].mean(), df['name'].median(), df['name'].std(), etc.).
- Many others

Inferential statistics often require **dedicated packages**.

- We focus on **SciPy**



Basic statistics in Python

- **SciPy ("Scientific Python")** is a scientific computing package built on top of **NumPy**.
- Aside from **inferential statistics**, SciPy also supports general **signal processing** (e.g., filtering), **linear algebra**, **differential equations**, **data interpolation** etc.
- **t-Test**: The most widely-used inferential statistic, probing whether the means of two groups are significantly different.
- If you do not know the t-test, **read the following before Monday**: https://datatab.net/tutorial/t-test
- SciPy supports many **more complex statistical tests**, so check it out!

Paired-sample t-test example

```
from scipy.stats import ttest_rel    #type: ignore
import numpy as np    #type: ignore

# Fake data
pre_test = [88, 92, 85, 91, 87, 95, 89]
post_test = [90, 94, 85, 93, 89, 97, 90]

# Perform the dependent (paired) t-test
t_stat, p_value = ttest_rel(pre_test, post_test)

# Print result
print(f"T-statistic: {t_stat:.3f}, P-value: {p_value:.3f}")
```

✓ 0.0s

```
T-statistic: -5.284, P-value: 0.002
```

Before the next practical, go through these slides again!

Do you know what the following terms mean?

- SciPy
- T-Test
- Inferential statistics
- Descriptive statistics
- Mean
- Median
- Standard deviation (std)


Have fun!