Artificial Intelligence

Algorithms and Applications with Python

Syllabus

TECHNISCHE UNIVERSITÄT DARMSTADT

WIRTSCHAFTS INFORMATIK

AIAA 1 + 2

Dr. Dominik Jung
dominik.jung@jung-isec.de

</> course material: ↗ www.github.com/dominikjung42 | recordings: ↗ www.youtube.com/c/dominikjung42 | syllabus: ↗ www.is.tu-darmstadt.de

About Me

EXPERIENCE

Since 2024 Team Lead Data Science & AI , Procurement & Purchasing, *Porsche AG*

2019 - 2024 Data Scientist, After-Sales, *Porsche AG*

2016-2019 Research Assistant, *Karlsruhe Institute of Technology (KIT)*

EDUCATION

2016-2018 Dr. rer. pol., Information Systems, *KIT*

2015-2018 M.Sc., Practical Computer Science, *University of Hagen*

2013-2015 M.Sc., Information Management and Engineering, *KIT*

2009-2013 B.Sc., Media Economics & B.A., Applied Media and Communication Studies, *Ilmenau University of Technology*

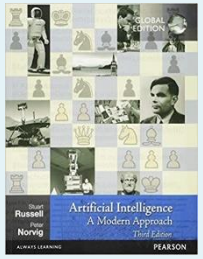
RESEARCH INTERESTS

- Applied Artificial Intelligence
- Decision Intelligence, Decision Support
- AI-based Systems (*Robo-Advisors, Conversational Agents, DSS etc.)*

Further Questions?

Please send me an email at
dominik.jung42@jung-isec.com

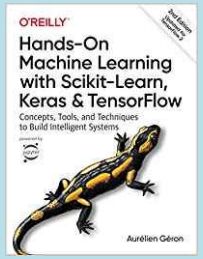
Relevant Literature



Rusell, S, & Norvig, P. *Artificial Intelligence: A Modern Approach.* Global Edition.

Main course book, relevant for all chapters

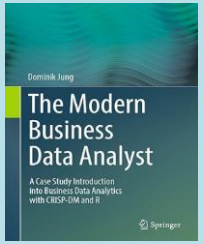
▶ Availability: ↗University Library Darmstadt | ↗Amazon



Géron, A. *Hands-on Machine Learning with Scikit-learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems.*

Relevant for ch. 6 machine learning, ch. 7 neural networks, ch.9 natural language processing and ch.10 computer vision

▶ Availability: ↗University Library Darmstadt | ↗Amazon

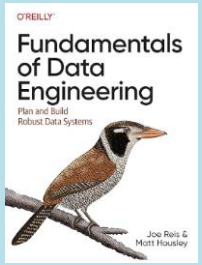


Jung, D. The Modern Business Data Analyst: A Case Study Introduction into Business Data Analytics with CRISP-DM and R

Relevant for ch. 11 building productive AI-systems and the AI capstone

▶ Availability: ↗Amazon

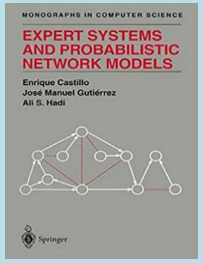
Further Literature



Reis, J., & Housley, M. *Fundamentals of Data Engineering: Plan and Build Robust Data Systems*.

Relevant for ch. 4 data and feature engineering with python and ch. 11 building productive AI-systems and the AI capstone.

- Availability: ↗Amazon

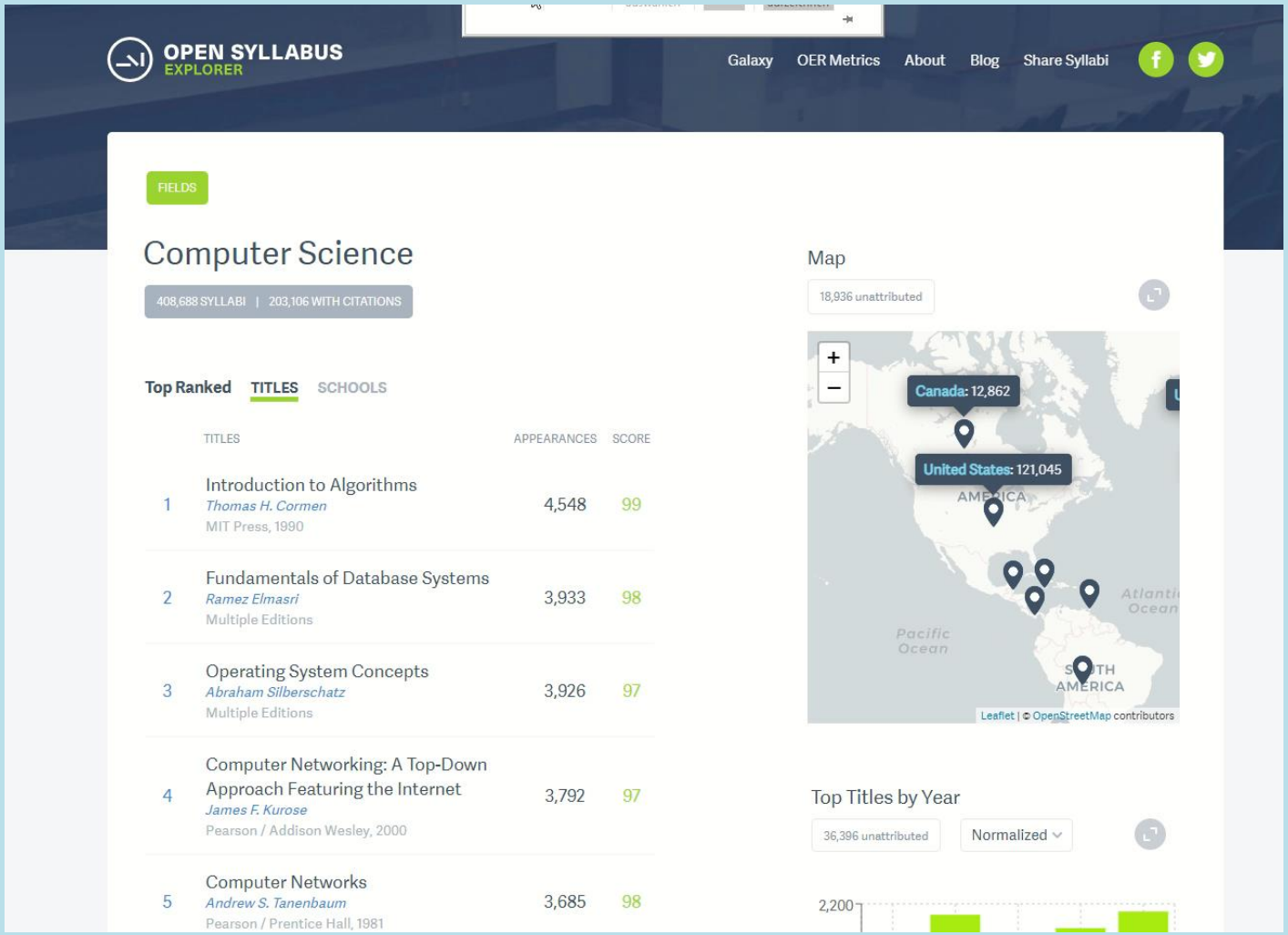


Castillo, E, Gutierrez, JM, & Hadi, AS. *Expert Systems and Probabilistic Network Models*. Springer Science & Business Media.

Relevant for ch. 5 knowledge reasoning and representation

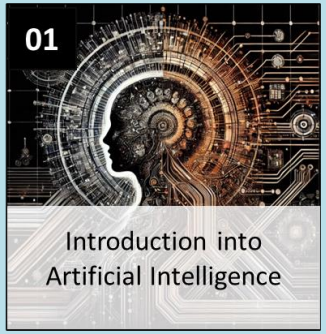
- Availability: ↗Amazon

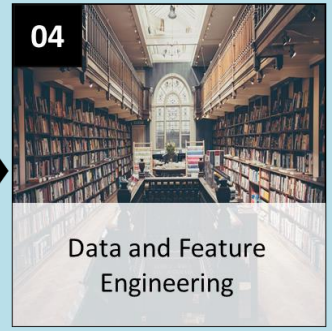
Rusell, S., & Norvig, P. (2016)

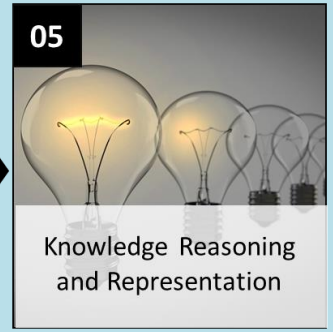


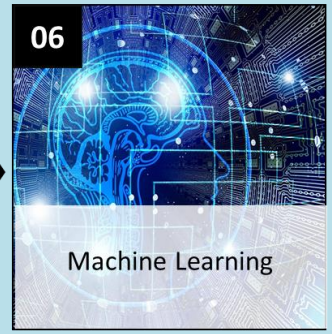
Russell and Norvigs textbook is the most used AI teaching book in about 1500 universities world wide (↗*Open Syllabus*). Please use the complementary textbook website of this course for exercises and exam preparation. You find there further materials, tutorials and code examples (↗*AIMA Berkley*).

Syllabus





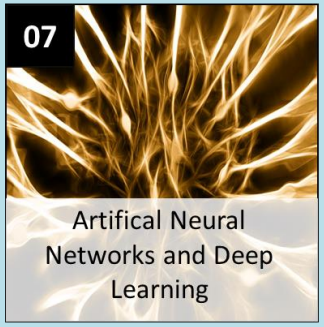


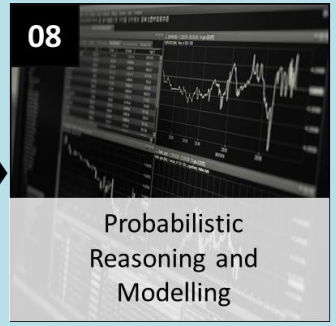


Workbook Exercises

Code Lectorial
Python

Workbook & Coding Exercises





Workbook & Coding Exercises

Further units:

- Live Coding Sessions
- Consultation Hours
- Capstone

Who Should Choose this Lecture

This lecture is aimed at two complementary audiences:

- **Intermediate information systems / computer science students** who want to get a general understanding of artificial intelligence (AI), understand how AI works, and learn new strategies for solving diverse AI problems.
- **Students from other domains** who are planning to use AI methods (e.g. machine learning) in their future (e.g. thesis, internship) and want to understand why it works the way it does.

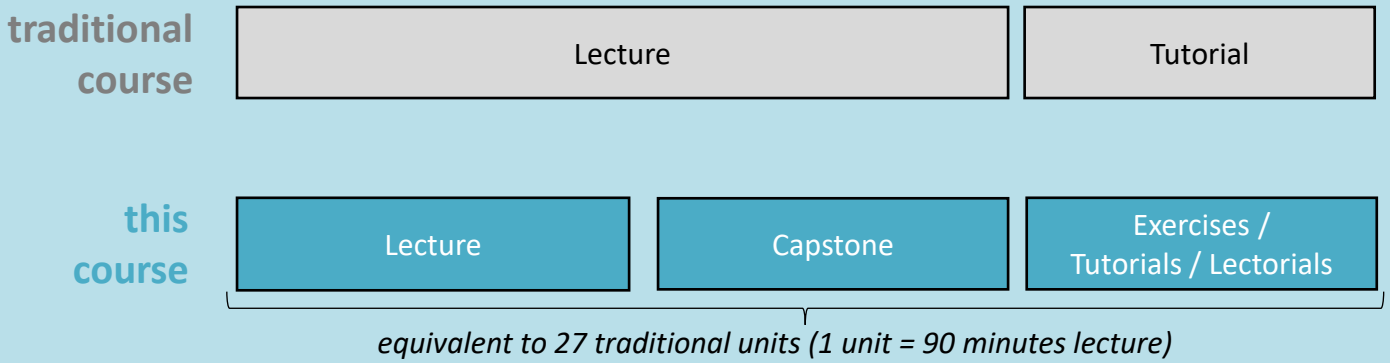
What You Will Get Out of this Course

- This course **delivers the knowledge that I think an AI specialist should possess**: a **general understanding** of the **fundamentals** coupled with a **broad knowledge in central algorithms and concepts**. That means that you can **tactically learn more about a topic when needed**.

- At the end of this course, you will:
  - Be able to **design, implement and maintain AI systems** in **Python**
  - Have profound **knowledge about key concepts and algorithms** in AI
  - **Be good enough to sign up for advanced AI** related courses like machine learning, computer vision etc.
  - Have enough **basic knowledge to apply for beginner AI jobs** in industry

Outline and Organization

Course Organisation



***Lecture**: on-site / online*
***Lectorials**: online with Q&A after lecture*
***Exercise and Tutorials:** on-site*

Team

Dr. Dominik Jung
dominik.jung@jung-isec.de

Dr. Timo Sturm
sturm@is.tu-darmstadt.de

General Questions:
ki@is.tu-darmstadt.de

Guiding Principle of the Course

You're not being hired for knowledge, but how you apply the knowledge!

Please note that I revise this course every semester. If you visit this course and plan to write the exam later you have to check if some subchapters were added or excluded for the current exam. I do this due to the capstone project and new trends in AI.

Outline and Organization Winter term 2024

The course is planned as hybrid course (see next slides), while the latest lecture and tutorials will only be on-site.

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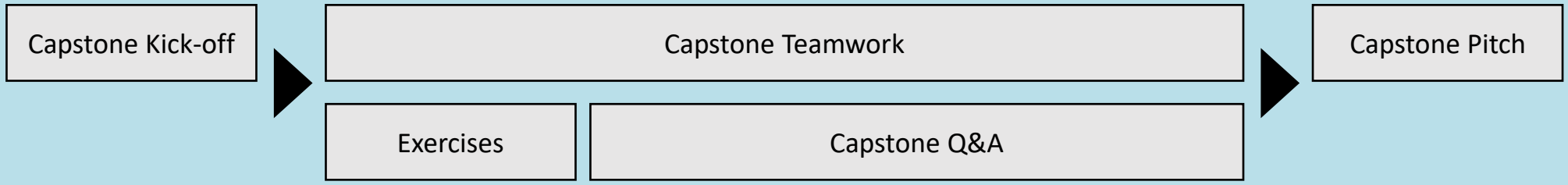
ID	Date	Start	End	Room	Chapters and Content	Lecturer
1	Fr, 18.10.2024	9:50	12:25	S311/0012	▪ Syllabus ▪ Ch. 1 - Introduction into Artificial Intelligence	Dr. Dominik Jung
2	Fr, 18.10.2024	14:25	15:55	S103/23	▪ Ch. 3 - Introduction into AI-Programming with Python	Dr. Dominik Jung
3	Fr, 25.10.2024	9:50	12:50	S311/0012	▪ Ch. 2 - Search, Problem Solving, and Planning	Dr. Timo Sturm
4	Fr, 01.11.2024	9:50	12:50	S311/0012	▪ Ch. 4 - Data and Feature Engineering with Python ▪ Ch. 5 - Knowledge Reasoning and Representation	Dr. Dominik Jung
5	Fr, 01.11.2024	14:25 *(tba 14:45)*	17:55	S103/23	▪ Ch. 6 - Machine Learning ▪ Lectorial 1 + 2	Dr. Dominik Jung
6	Fr, 08.11.2024	9:50	12:50	S311/0012	▪ Ch. 7 - Artificial Neural Networks and Deep Learning ▪ Lectorial 3	Dr. Dominik Jung
7	Fr, 08.11.2024	14:25	17:55	S103/23	▪ Ch. 8 - Probabilistic Reasoning and Modelling ▪ Ch. 9 - Natural Language Processing ▪ Guest Lecture ▪ Lectorial 4	Dr. Dominik Jung
8	Fr, 15.11.2024	9:50	12:50	S311/0012	▪ Ch. 10 - Computer Vision and Image Processing ▪ Lectorial 5	Dr. Timo Sturm
9	Fr, 22.11.2024 *Christmas Lecture*	9:50	12:50	S311/0012	▪ Ch. 11 - Building Productive AI-based Systems ▪ Course Evaluation	Dr. Dominik Jung
10	Fr, 29.11.2024	9:50	12:50	S311/0012	▪ *Alternative date for cancelled lectures (hybrid)*	tbd
11	tbd	tbd	tbd	online	▪ Exam Q&A (online)	Dr. Dominik Jung

General Questions: *ki@is.tu-darmstadt.de*

Outline and Organization Summer Term

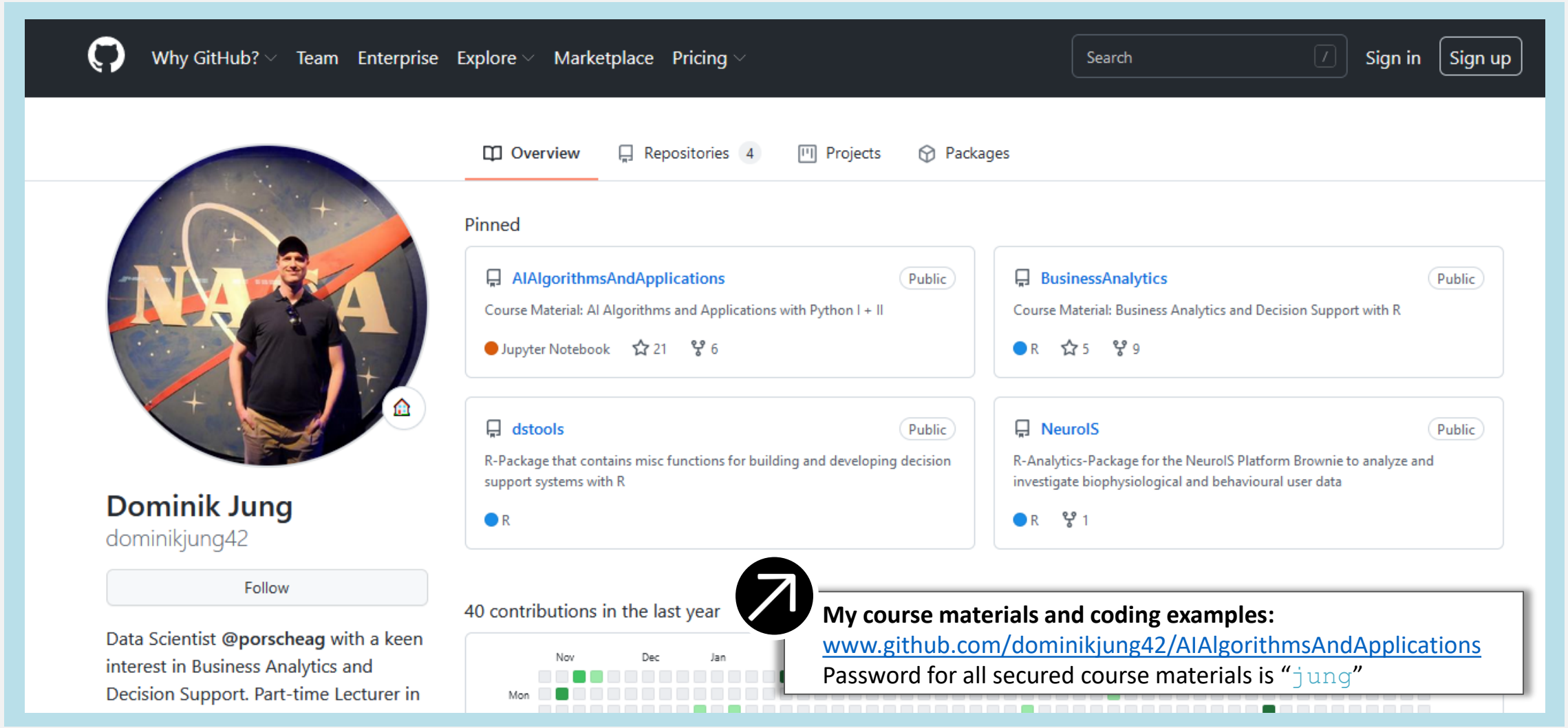
TECHNISCHE UNIVERSITÄT DARMSTADT

ID	Event	Date	Lecturer
1	▪ Guest Lecture ▪ Capstone Kick-off	Friday	Dr. Dominik Jung Porsche AG Team
2	▪ Exercise	Thursday	Dr. Timo Sturm
3	▪ Capstone Q&A	Weekly	Porsche AG Team
4	▪ Capstone Pitch	Friday	All

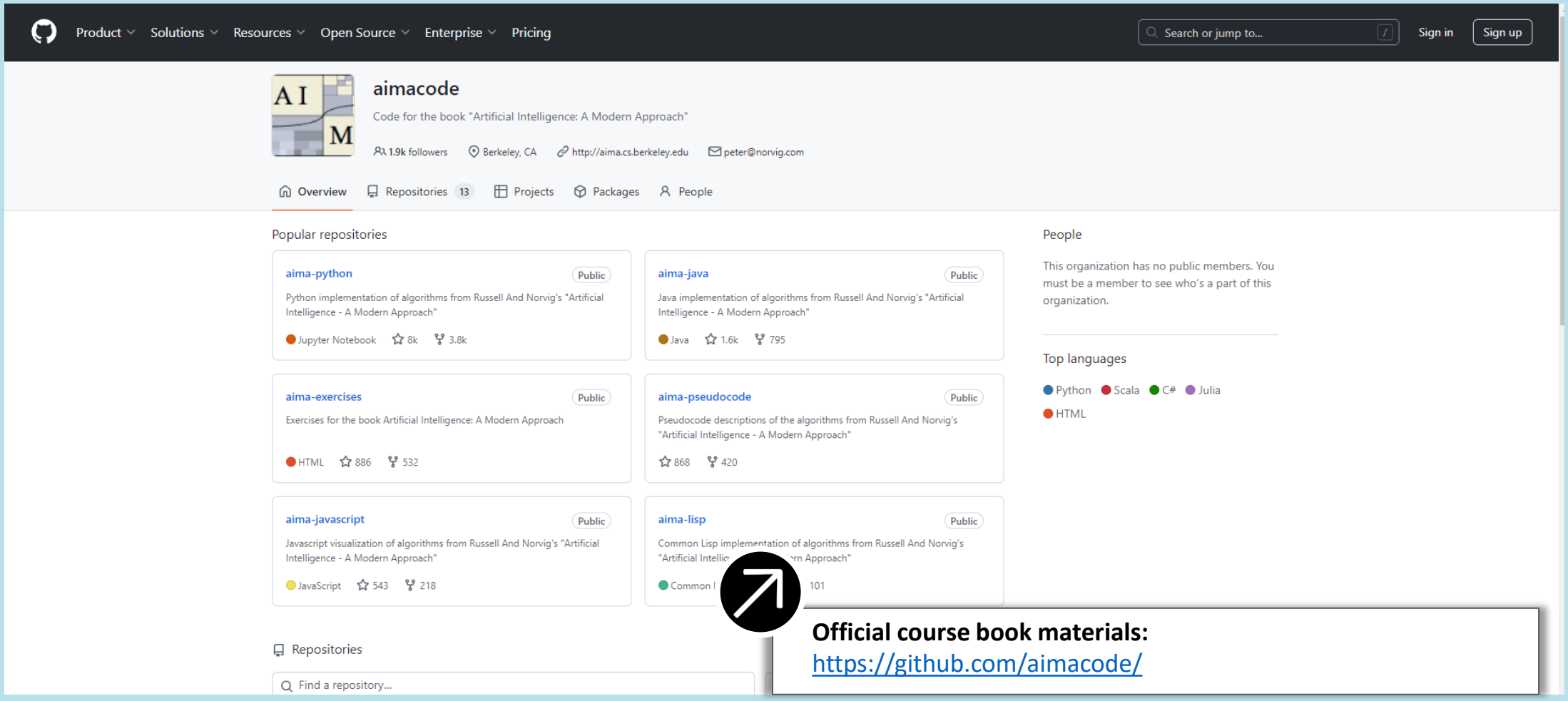


General Questions: *ki@is.tu-darmstadt.de*

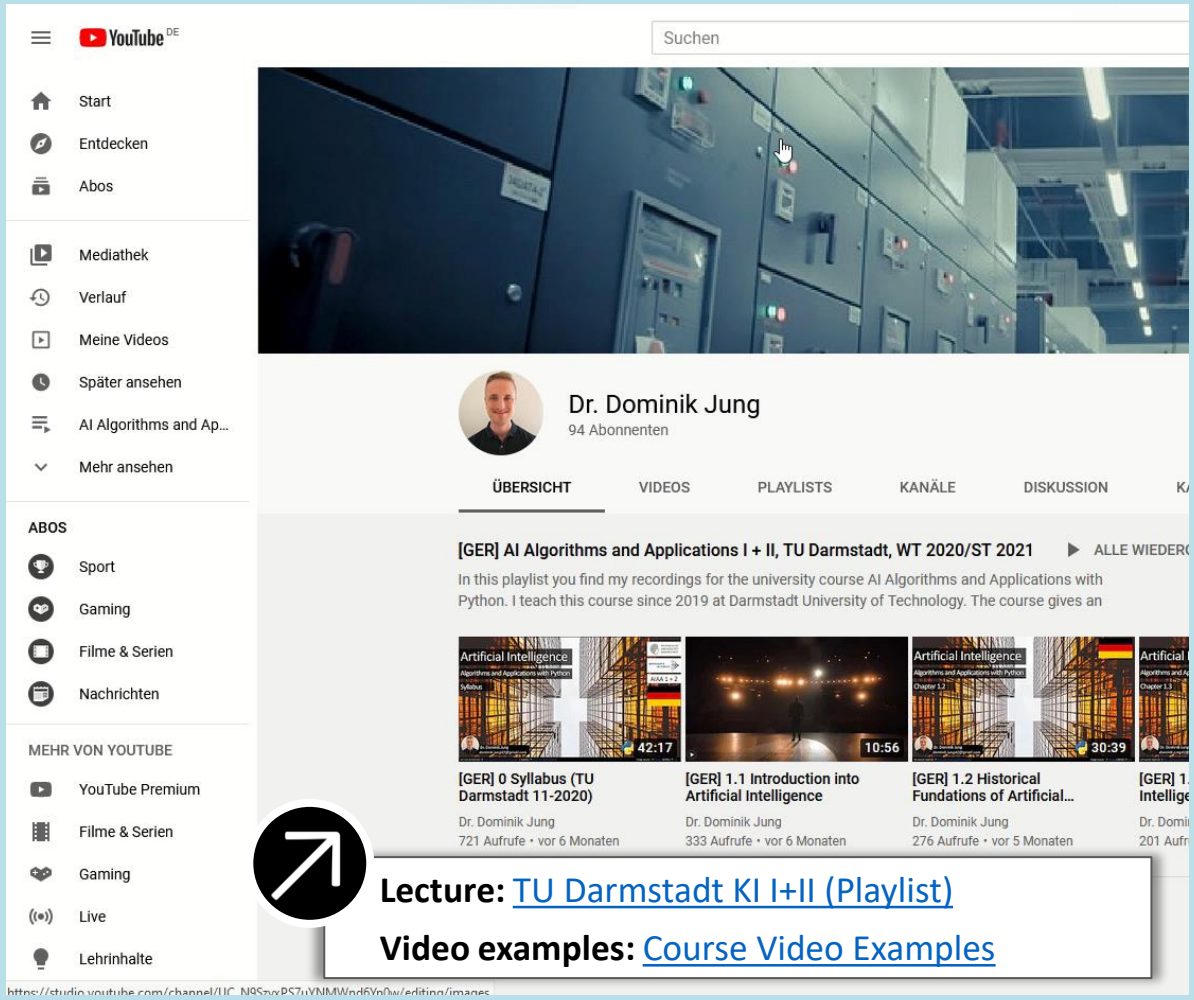
Course Material



Course Book Material



Course Recordings



Hybrid/Online Lecture Setup

- Selected lecture recordings and exercises will be online available at Youtube on my channel: *www.youtube.com/c/dominikjung42*
- Teaching material accompanying this lecture and all literature downloads and course material will be available in GIT: *www.github.com/dominikjung42*
- Please feel free to comment the videos to solve the class room tasks.
- Click "Subscribe" to get informed about new videos.

Todos until next Lecture!

Please install

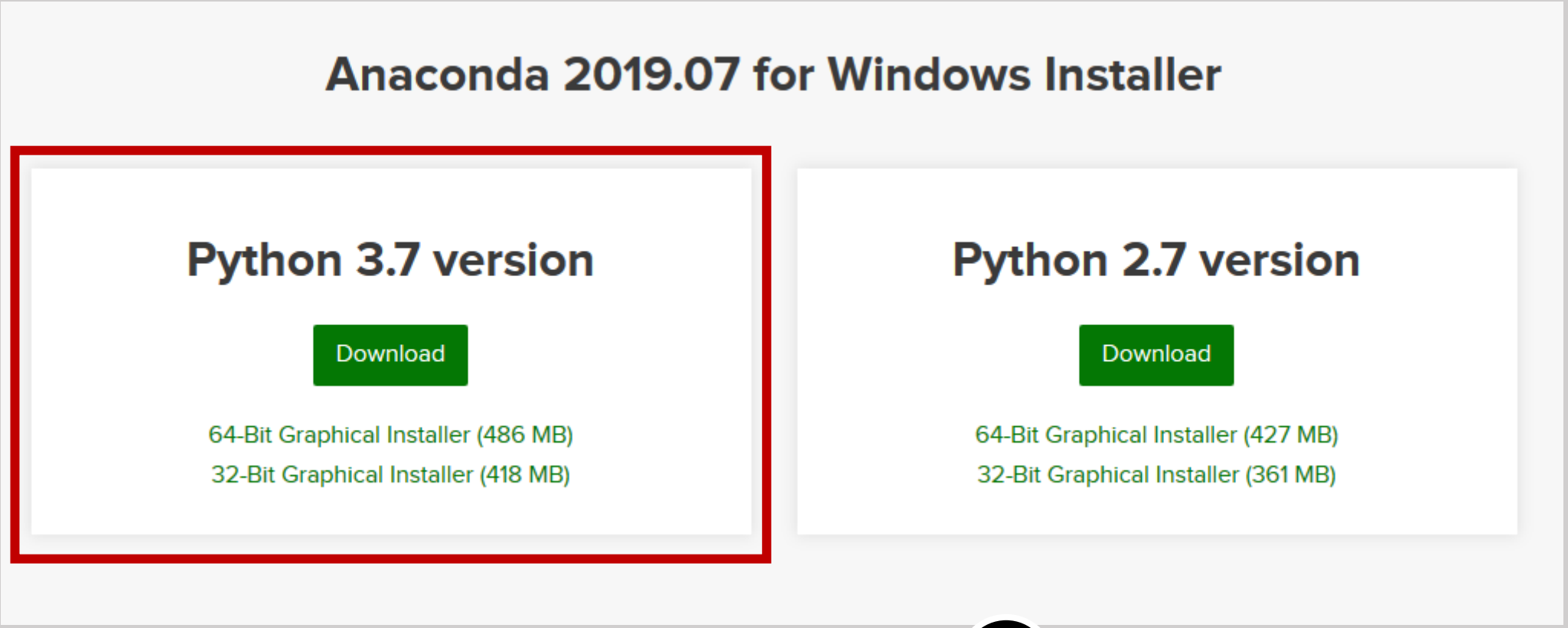
- Anaconda: https://www.anaconda.com/distribution
- GIT: https://git-scm.com/downloads | https://gitforwindows.org

until **next** lecture

You will need them to solve the exercises in this course

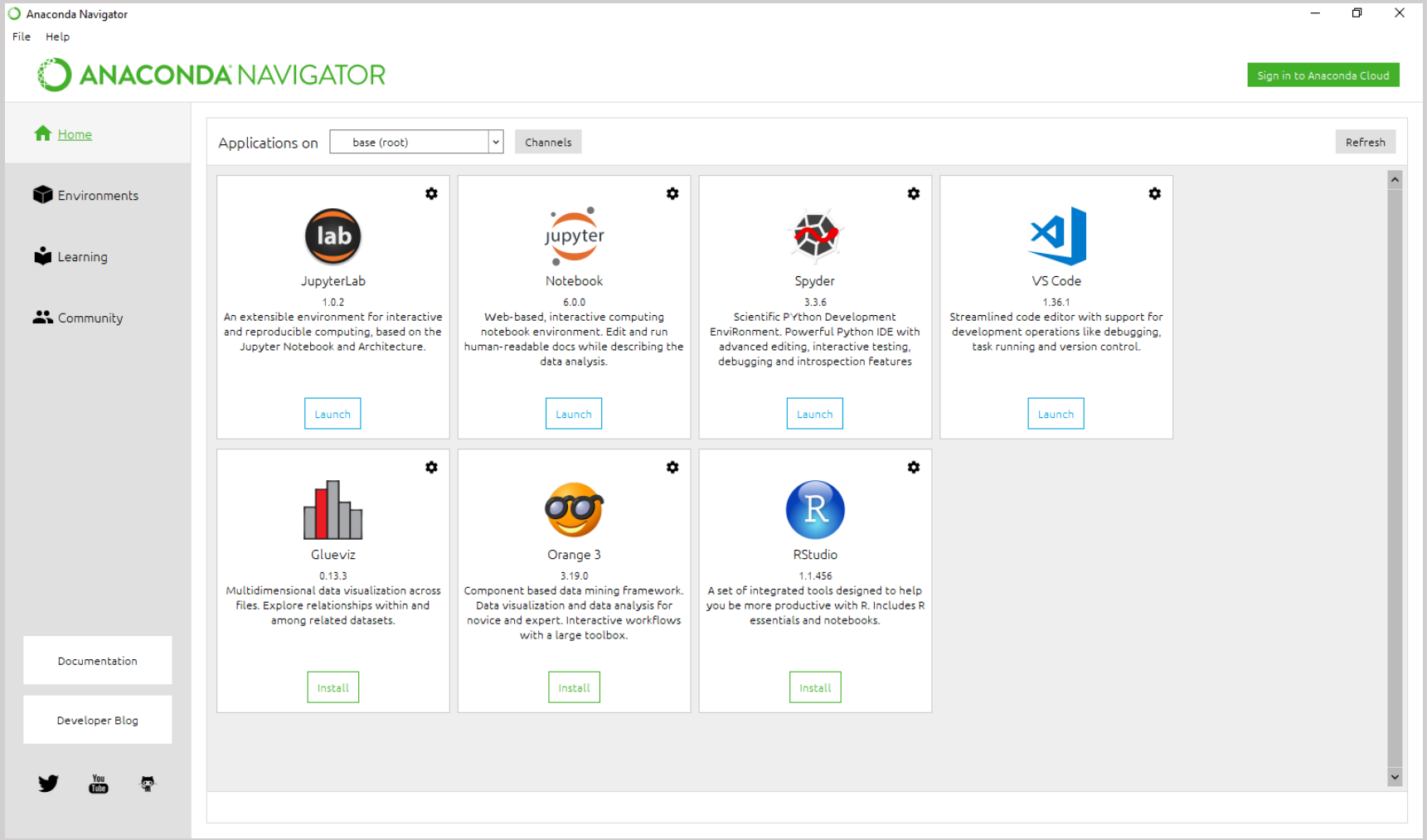
All tools of this course are available for Linux, Windows and Apple!

Download Anaconda

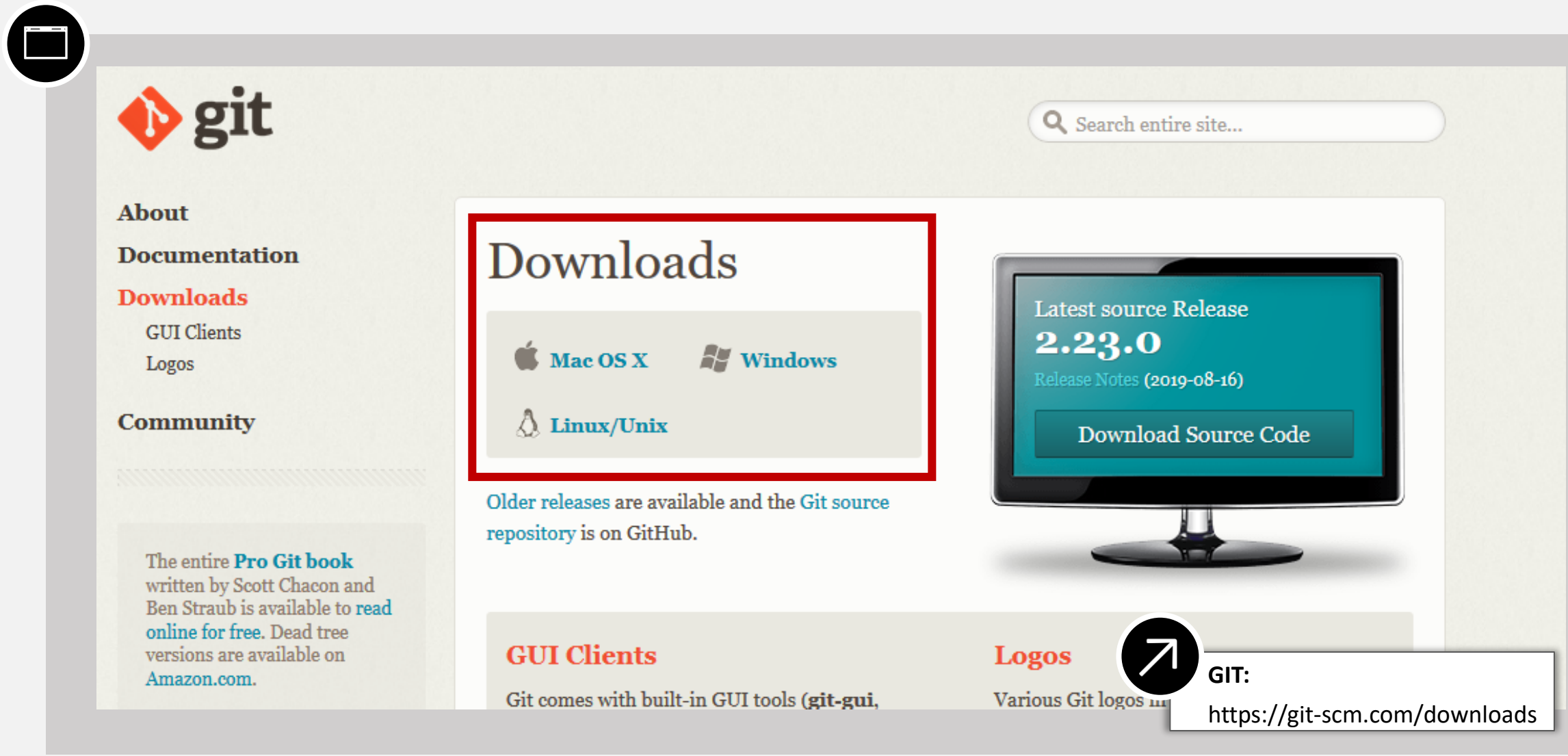


Anaconda Platform:
https://www.anaconda.com/distribution

Setup Anaconda



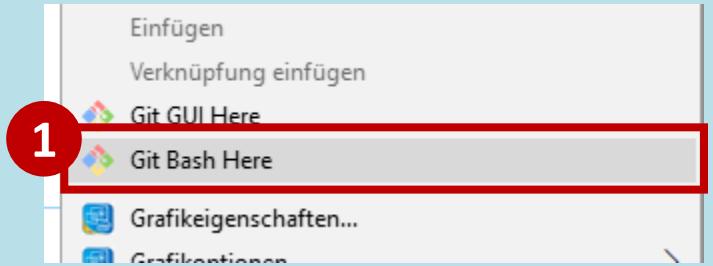
Download GIT



Setup GIT - Download the Course Material

Console

- Register @git
- Make a new folder and make a right-click, choose "Git Bash here"



No reason to panic! If you have trouble contact me, I will help you to setup your repository!

- Run the following lines of code in your Git Bash to setup your repository

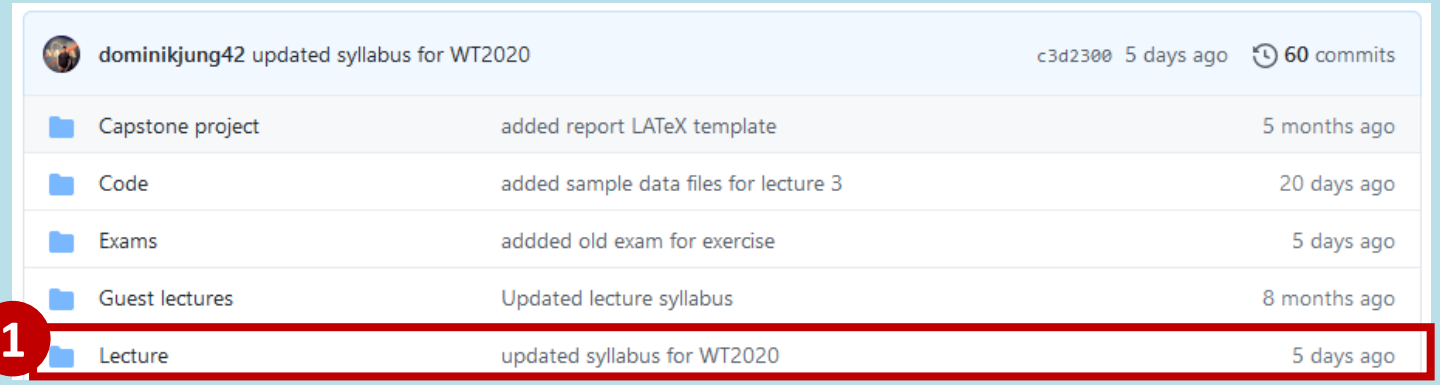
```
git init
git config --global user.name "YOUR NAME"
git config --global user.email "YOUR EMAIL"
git clone "https://github.com/dominikjung42/AIAlgorithmsAndApplications.git"
```

- During the course, run the following lines of code to update your repository

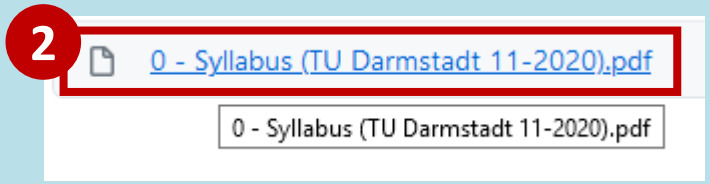
```
git pull origin master
```

Or Download the Course Materials Manually

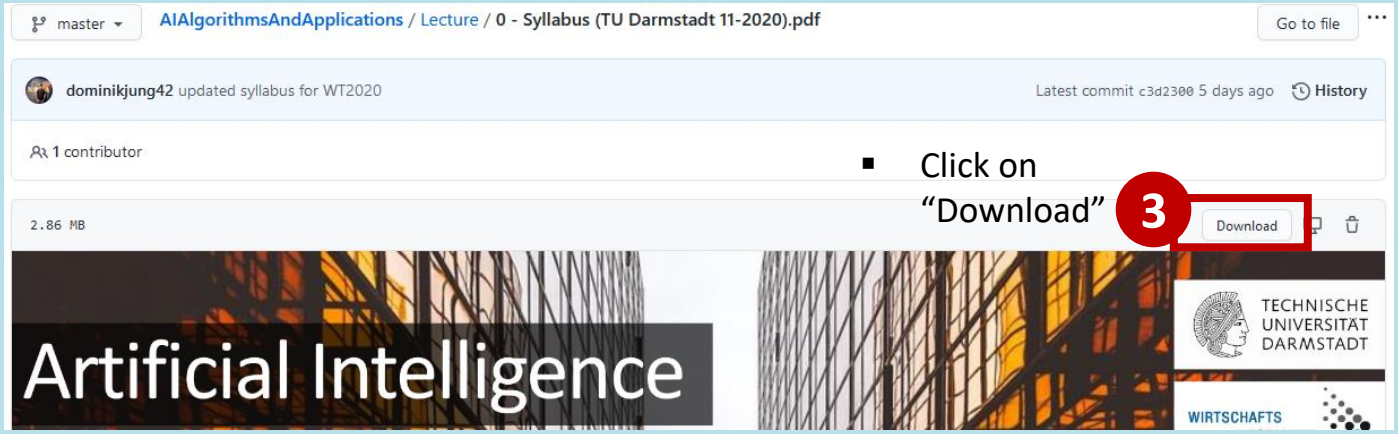
Console



- Open the Git repository and select the folder with the files you are interested in



- Click on the file you want to download



- Click on “Download”

Teaching Material Icons

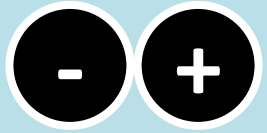

Important note


Classroom question or task


Definition


Problem / Solution


Referenced package/library


Pro / Contra


Referenced handout


Weblink or external ressource

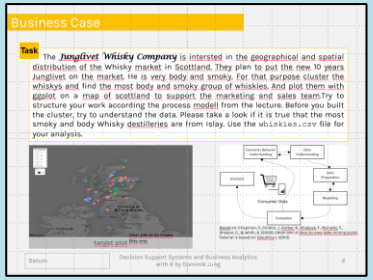

Information about self-studying or other lectures (not explicitly exam relevant if not said otherwise)

Types of Tasks and Exercises

Classroom Task

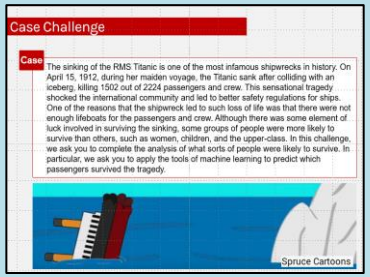
- Short tasks, workload should be about 5 minutes
- Solved during lecture
- Use it for exam preparation

Classroom Case



- Simplified, real-world business-problems and cases
- Workload between 30-60 minutes
- Read and Discuss
- Use it to deepen your applied skills

Challenge / Capstone



- General task with a wide focus on the different topics of the course
- Workload <u>to pass</u> the challenge is about 6-8 hours, and about 2-4 weeks fulltime for the capstone

Business Case

- Typical business case
- Discussed together

Capstone Challenge @ Porsche AG (2022)

Closed Book and Closed Notes Exam (preliminary!)*

33 %

BASIC CONCEPTS AND THEORETICAL BACKGROUND

- You will have to answer multiple questions related to basic concepts of the lecture or give basic definitions or formulas.
- Aka “knowledge questions”.

33 %

APPLYING THEORY TO PRACTICE

- You will have to show that you understand the algorithms and concepts and that you can use them to solve a (business/real-life) problem.
- For this kind of task you might need your calculator or geometrical triangle, pen and eraser.

34 %

PROGRAMMING

- You will have to write, read and understand code examples in the context of artificial intelligence problems (search, machine learning, etc.).
- Use the exercises, lectorials and the code examples to prepare!

**Note: It may be possible that the point distribution differs in the final exam*

Which Content is Relevant for the Exam?

Outline

2 Artificial Intelligence and Information Systems

- 2.1 Artificial Intelligence Project Management
- 2.2 Artificial Intelligence Project Lifecycle
- 2.3 Skills and Roles in Artificial Intelligence Projects
- 2.4 Types of Artificial Intelligence based Information Systems

▶ **What we will learn:**

- How typical AI projects are implemented, and how their life cycle and phases look like
- What skills are needed to implement an AI project
- Why the industry needs AI specialists, and how typical AI jobs look like
- Which types of AI based information systems exists and how they can be used to solve real-world problems

Image source: Pixabay (2019) / CC0

▶ **Duration:**

- 120 min

▶ **Relevant for Exam:**

- 2.1-2.4

Artifical Intelligence: Building AI-Based Information Systems with Python - Dr. Dominik Jung

Note: There might still be questions where you might need a basic understanding of the content of the excluded chapters

Always exam relevant

- **Lecture** slides, **lectorials** and **exercises** (*except excluded chapters on the overview*)
- **Referenced chapters** of **the course books** and **all literature downloads** available in GIT (*look at the folder "literature"*)
- The **handouts** for the business cases and the **discussion results**
- **Every teaching material** accompanying this lecture (**code examples**, guest lectures etc.)

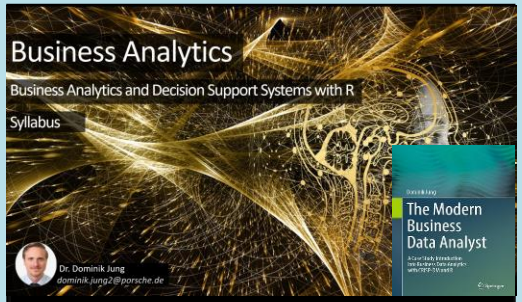
Grading (preliminary)

Contact	Description	Distribution
Exam *Dr. Dominik Jung*	There will be a 90 minutes closed-book/closed-notes exam consisting of short-answer, and analytical questions covering all course material! One third will be general questions, one third related to tools, and the last third will be an overarching case.	60 %
Capstone Project *Dr. Timo Sturm + Capstone Partners*	Each participant is expected to join a team of about 4 students to analyze and work on a capstone project. Results should be delivered in a document. Further information will be presented at the capstone introduction.	40 %

- Both elements need to be passed (grade 4.0 or better): Failing (i.e., grade 5.0) the (1) Exam, or the (2) Case Study, or (3) the Exam and the Case Study, results in failing the entire course.
- There is no retake possibility for the Capstone project. Thus, if you fail the Capstone project, you need to retake the course next year!

Related Courses

Data Science Lectures



Business Analytics and Decision Support with R

Modelling and Analyzing User-Behaviour with R

AI Applications and Algorithms with Python (I + II)

Data Science Seminars

Web and Media Analytics with Python and R

Data Design and Visualization with R and Inkscape

Check out my git repository for the course material and more information!

References

Main literature

1. Rusell, S., & Norvig, P. (2016). *Artificial Intelligence: A Modern Approach.* Global Edition
2. Géron, A. (2017). *Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems.*
3. Castillo, E., Gutierrez, J. M., & Hadi, A. S. (2012). *Expert systems and probabilistic network models*. Springer Science & Business Media.

Further reading

- I strongly recommend to take a look at the free available online version of the *Pro Git book*, written by Scott Chacon and Ben Straub and published by Apress, it is available online as pdf, epub and mobi (↗ git-scm.com).
- *Rogerdudler Git Tutorial* (↗ https://rogerdudler.github.io/git-guide) gives an excellent introduction for getting started with git.
- I also can recommend to take a look at the GIT guide from *kbroman* (↗ kbroman.org).