

Artificial Intelligence

Algorithms and Applications with Python

Syllabus



TECHNISCHE
UNIVERSITÄT
DARMSTADT



WIRTSCHAFTS
INFORMATIK

AIAA 1 + 2



Dr. Dominik Jung
dominik.jung42@gmail.com



python

EXPERIENCE

- Since 2019** Data Scientist, After-Sales, *Porsche AG*
- 2016-2019** Research Assistant, *Institute of Information Systems and Marketing (IISM) and Karlsruhe Decision & Design Lab (KD2 Lab)*

EDUCATION

- 2016-2018** Dr. rer. pol., “Robo-Advisors and Decision Inertia”, *Karlsruhe Institute of Technology*
- 2015-2018** M.Sc., Practical Computer Science, *University of Hagen*
- 2013-2015** M.Sc., Information Management and Engineering, *Karlsruhe Institute of Technology*
- 2009-2013** B.Sc., Media Economics & B.A., Applied Media and Communication Studies, *Ilmenau University of Technology*

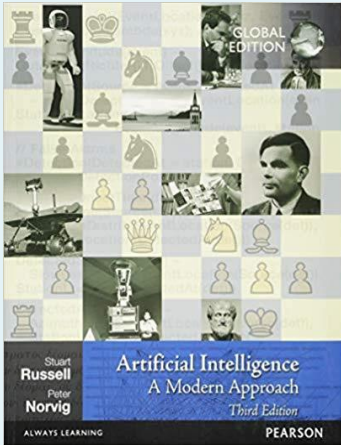
RESEARCH INTERESTS

- Decision Support Systems (*e.g. Robo-Advisors, Dashboards*)
- Modeling and Analyzing User Behavior with R / Python



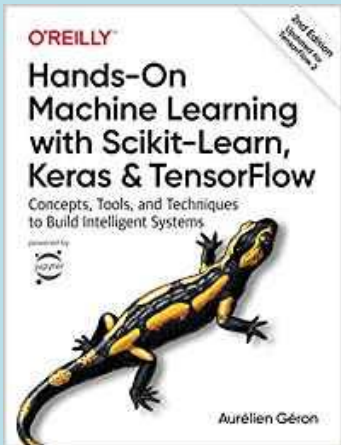
Further Questions?

Please send me an email at dominik.jung42@gmail.com



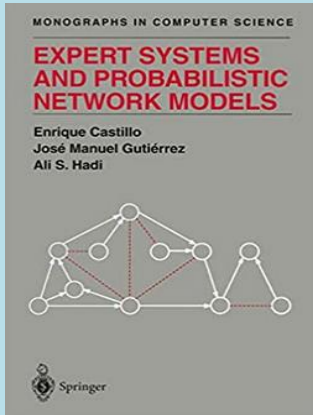
Russell, S., & Norvig, P. (2016). *Artificial Intelligence: A Modern Approach*. Global Edition.

► Availability: ↗[University Library Darmstadt](#) | ↗[Amazon](#)



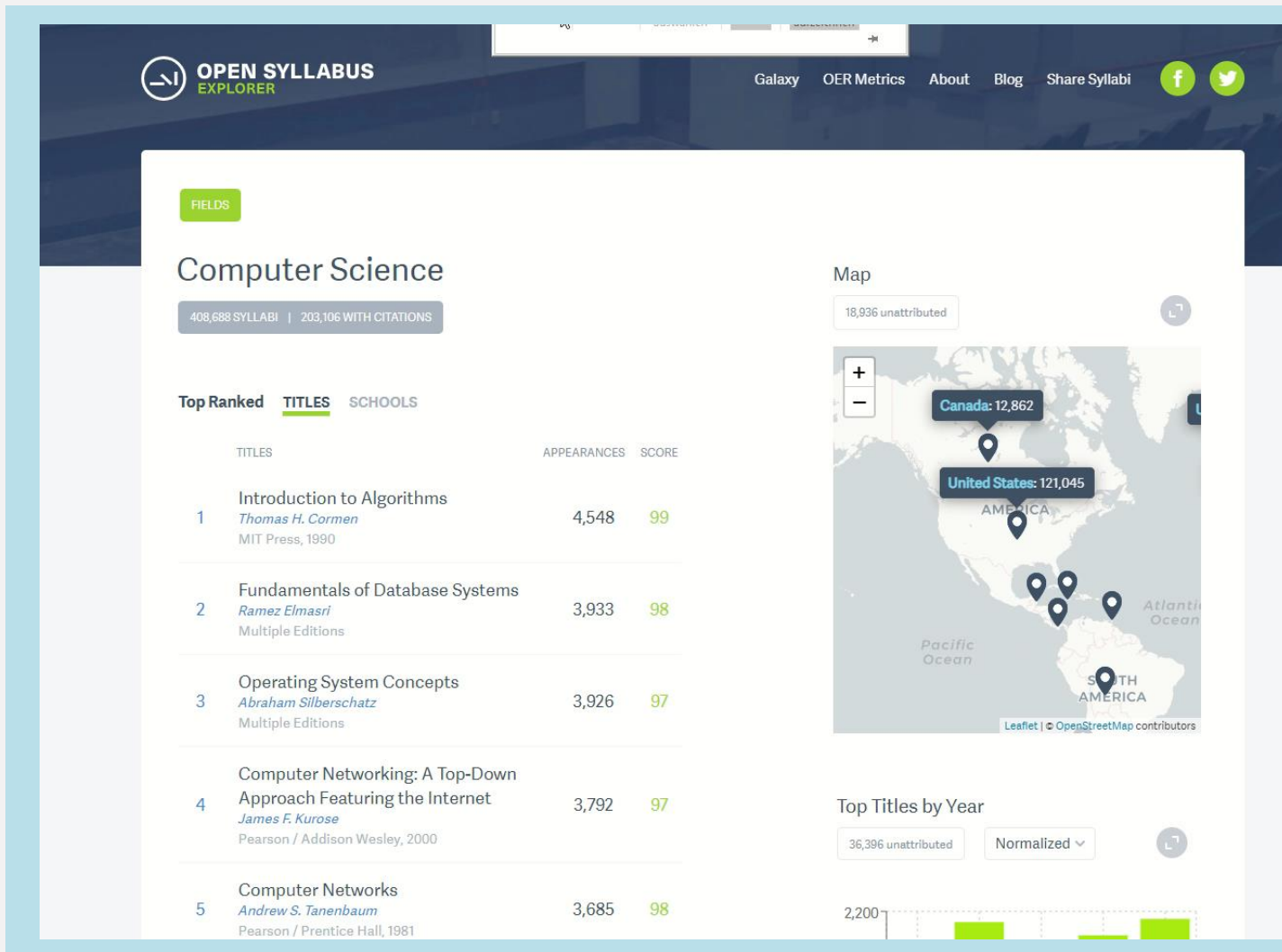
Géron, A. (2017). *Hands-on machine learning with scikit-learn and TensorFlow: Concepts, tools, and techniques to build intelligent systems*.

► Availability: ↗[University Library Darmstadt](#) | ↗[Amazon](#)



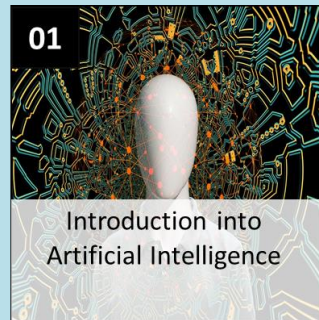
Castillo, E., Gutierrez, J. M., & Hadi, A. S. (2012). *Expert systems and probabilistic network models*. Springer Science & Business Media.

► Availability: ↗ [Amazon](#)



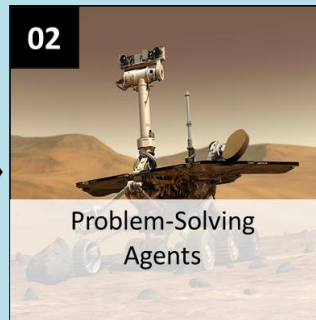
Russell and Norvigs textbook is the most used AI teaching book in about 1500 universities world wide ([↗Open Syllabus](#)). Please use the complementary textbook website of this course for exercises and exam preparation. You find there further materials, tutorials and code examples ([↗AIMA Berkley](#)).

Syllabus



01

Introduction into
Artificial Intelligence



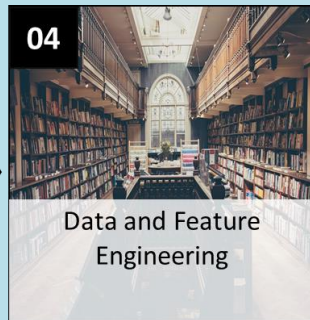
02

Problem-Solving
Agents



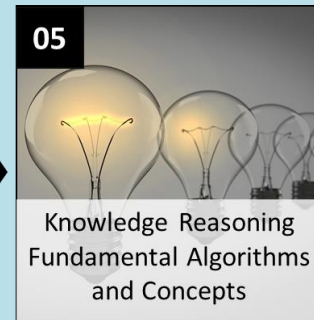
03

Introduction into AI-
Programming with
Python



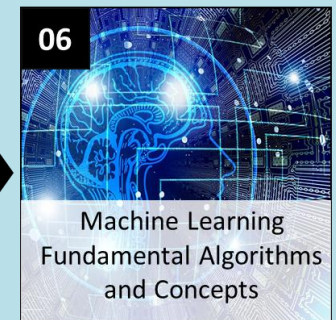
04

Data and Feature
Engineering



05

Knowledge Reasoning
Fundamental Algorithms
and Concepts



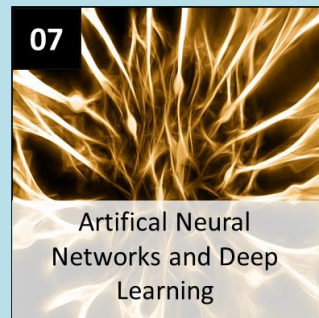
06

Machine Learning
Fundamental Algorithms
and Concepts

Workbook Exercises

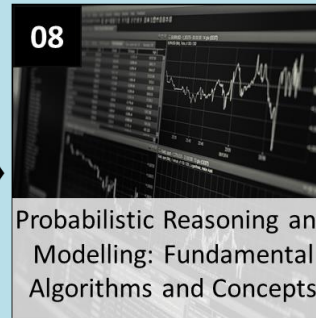
Code Lectorial
Python

Workbook & Coding Exercises



07

Artificial Neural
Networks and Deep
Learning



08

Probabilistic Reasoning and
Modelling: Fundamental
Algorithms and Concepts



09

Language and Image
Processing: Fundamental
Algorithms and Concepts



10

Building Productive AI-
based Information
Systems

Further units:

Live Coding Sessions

Consultation Hours

Capstone

Workbook & Coding Exercises

Image sources: ↗ [Pixabay](#) (2019) / ↗ [CC0](#)

Outline and Organization

Course Organisation

traditional
course

Lecture

Exercise

this
course

Lecture

Tutorials

Exercise

Lecture: online
Exercise: online

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.

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 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

The screenshot shows the GitHub profile of Dominik Jung. The profile includes a circular avatar with a NASA logo, the name 'Dominik Jung', and the username 'dominikjung42'. Below the name is a 'Follow' button and a bio: 'Data Scientist @porscheag with a keen interest in Business Analytics and Decision Support. Part-time Lecturer in'. The 'Repositories' tab is selected, showing four pinned repositories: 'AIAgorithmsAndApplications' (Python), 'BusinessAnalytics' (R), 'dstools' (R), and 'NeuroIS' (R). Annotations with arrows point to the first two repositories, providing links and a password.

Why GitHub? Team Enterprise Explore Marketplace Pricing Search / Sign in Sign up

Overview Repositories 4 Projects Packages

Pinned

- AIAgorithmsAndApplications** (Public)
Course Material: AI Algorithms and Applications with Python I + II
Jupyter Notebook 21 stars 6 forks
- BusinessAnalytics** (Public)
Course Material: Business Analytics and Decision Support with R
R 5 stars 9 forks
- dstools** (Public)
R-Package that contains misc functions f support systems with R
R
- NeuroIS** (Public)

Dominik Jung
dominikjung42
Follow

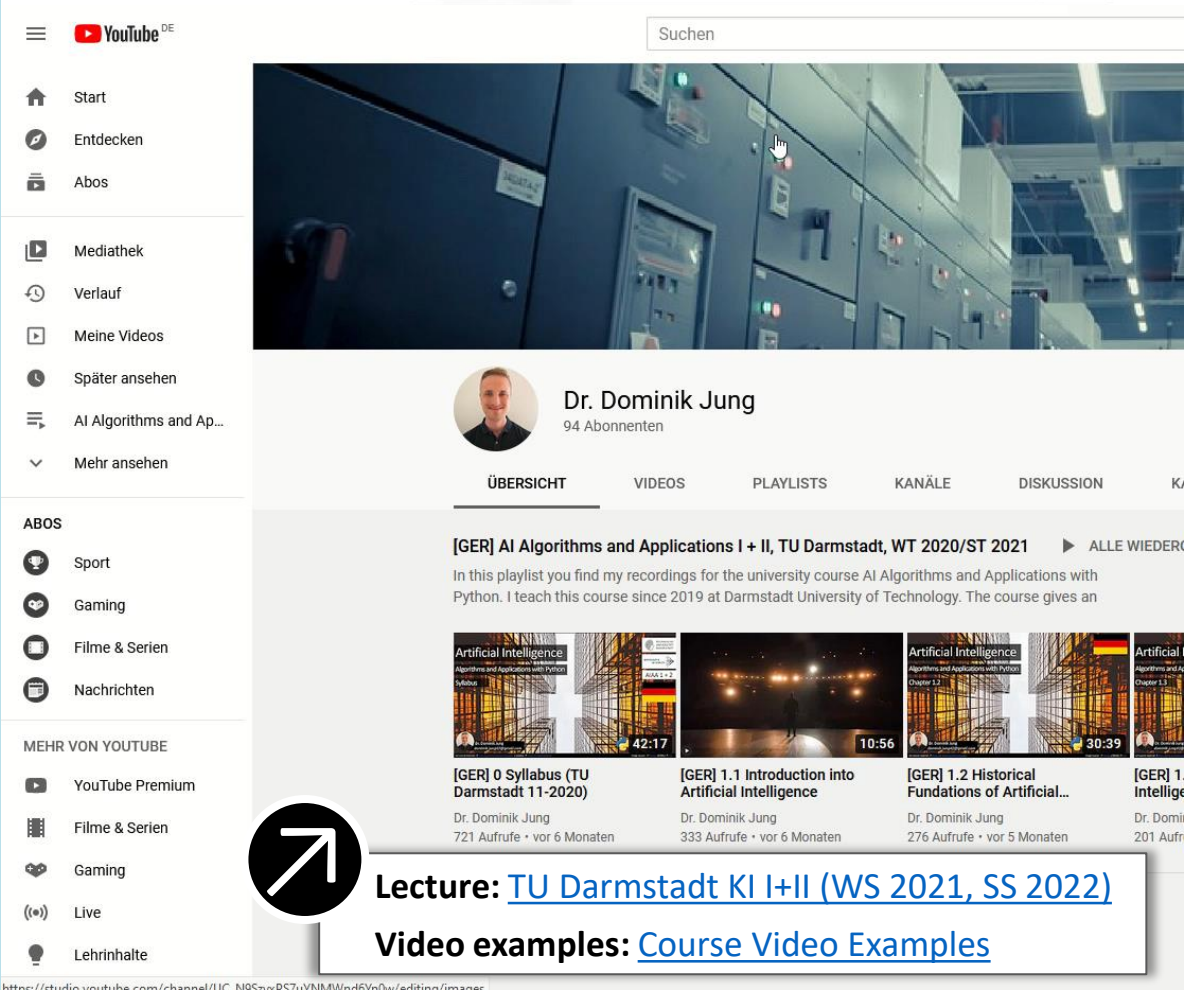
Data Scientist @porscheag with a keen interest in Business Analytics and Decision Support. Part-time Lecturer in

40 contributions in the last year

Nov Dec Jan
Mon

My course materials and coding examples:
www.github.com/dominikjung42/AIAgorithmsAndApplications
Password for all secured course materials is "jung"

Official course book materials:
www.github.com/aimacode



YouTube DE

Suchen

Start
Entdecken
Abos

Mediathek
Verlauf
Meine Videos
Später ansehen
AI Algorithms and Ap...
Mehr ansehen

ABOS

Sport
Gaming
Filme & Serien
Nachrichten

MEHR VON YOUTUBE

YouTube Premium
Filme & Serien
Gaming
Live
Lehrinhalte

Dr. Dominik Jung
94 Abonnenten

ÜBERSICHT VIDEOS PLAYLISTS KANÄLE DISKUSSION

[GER] AI Algorithms and Applications I + II, TU Darmstadt, WT 2020/ST 2021 ▶ ALLE WIEDERHOLEN

In this playlist you find my recordings for the university course AI Algorithms and Applications with Python. I teach this course since 2019 at Darmstadt University of Technology. The course gives an

Artificial Intelligence Algorithms and Applications with Python Chapter 0: Syllabus

[GER] 0 Syllabus (TU Darmstadt 11-2020)
Dr. Dominik Jung
721 Aufrufe · vor 6 Monaten

Artificial Intelligence Algorithms and Applications with Python Chapter 1.1: Introduction into Artificial Intelligence

[GER] 1.1 Introduction into Artificial Intelligence
Dr. Dominik Jung
333 Aufrufe · vor 6 Monaten

Artificial Intelligence Algorithms and Applications with Python Chapter 1.2: Historical Foundations of Artificial Intelligence

[GER] 1.2 Historical Foundations of Artificial...
Dr. Dominik Jung
276 Aufrufe · vor 5 Monaten

Artificial Intelligence Algorithms and Applications with Python Chapter 1.3: Intelligence

[GER] 1.3 Intelligence
Dr. Dominik Jung
201 Aufrufe · vor 5 Monaten

↗

Lecture: [TU Darmstadt KI I+II \(WS 2021, SS 2022\)](#)

Video examples: [Course Video Examples](#)

https://studio.youtube.com/channel/UC_N9SovPS7uVNMWnrd6Vn0w/editing/images

COVID19 Online Lecture Setup

- Lecture slides 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 “” to get informed about new videos.



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!



Anaconda 2019.07 for Windows Installer

Python 3.7 version

Download

64-Bit Graphical Installer (486 MB)

32-Bit Graphical Installer (418 MB)

Python 2.7 version

Download

64-Bit Graphical Installer (427 MB)

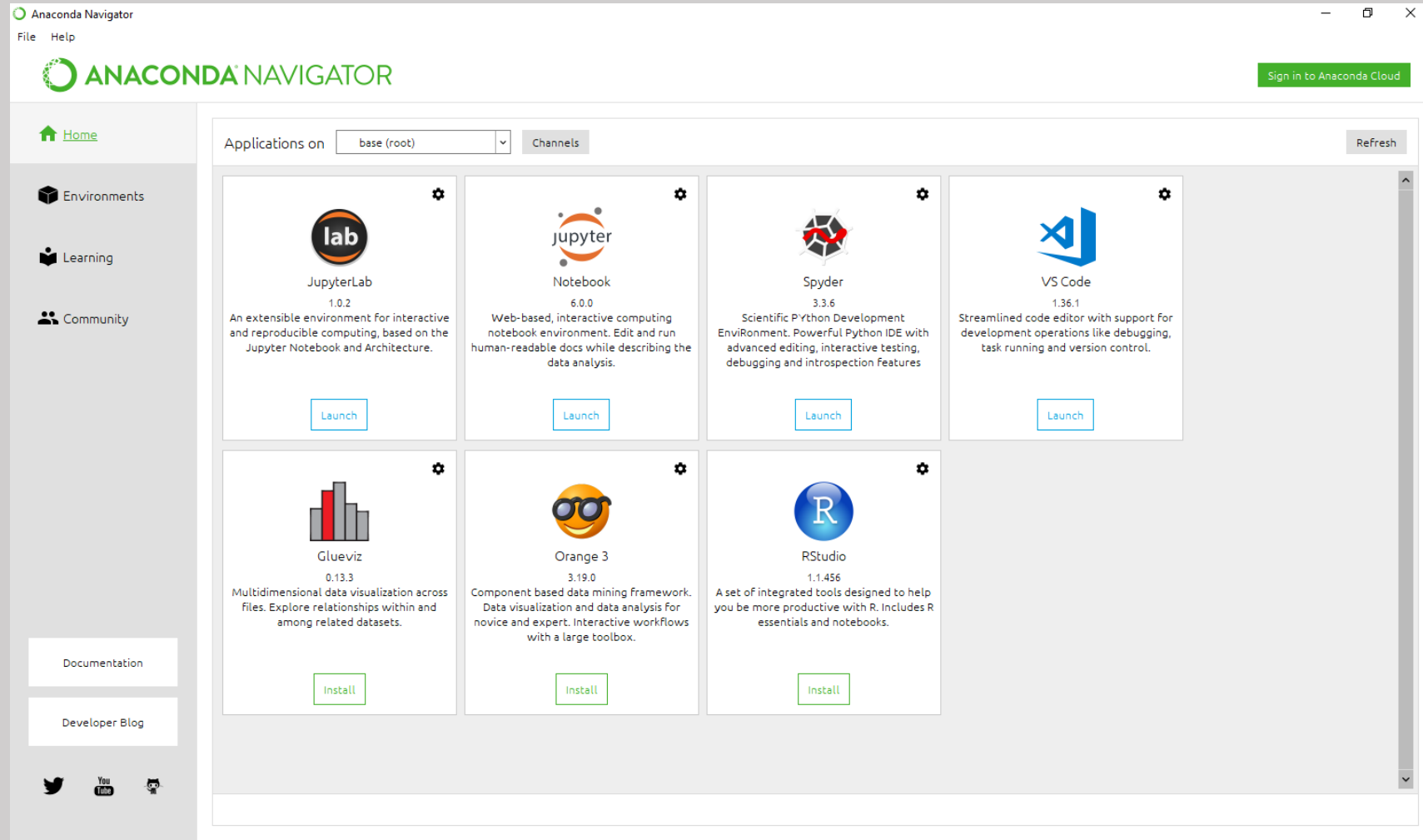
32-Bit Graphical Installer (361 MB)



Anaconda Platform:

<https://www.anaconda.com/distribution>

Setup Anaconda





git

Search entire site...

About

Documentation

Downloads

GUI Clients

Logos

Community

The entire **Pro Git book** written by Scott Chacon and Ben Straub is available to [read online for free](#). Dead tree versions are available on [Amazon.com](#).

Downloads

Mac OS X Windows Linux/Unix

Older releases are available and the [Git source repository](#) is on GitHub.

Latest source Release
2.23.0
[Release Notes](#) (2019-08-16)
[Download Source Code](#)

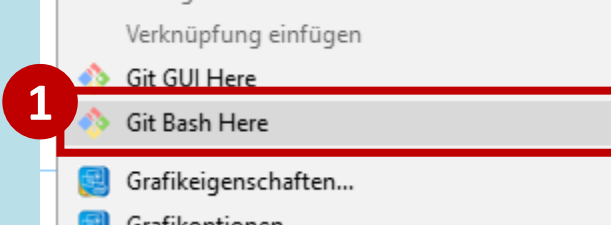
GUI Clients
Git comes with built-in GUI tools ([git-gui](#),

Logos
Various Git logos in

GIT:
<https://git-scm.com/downloads>

Setup GIT - Download the Course Material

Console

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

- 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
```



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

Or Download the Course Materials Manually

Console

| | | | |
|---|---|---------------------------------------|--------------|
|  | dominikjung42 updated syllabus for WT2020 | c3d2300 5 days ago | 🕒 60 commits |
| 📁 | Capstone project | added report LATEX template | 5 months ago |
| 📁 | Code | added sample data files for lecture 3 | 20 days ago |
| 📁 | Exams | added old exam for exercise | 5 days ago |
| 📁 | Guest lectures | Updated lecture syllabus | 8 months ago |
| 1 📁 | Lecture | updated syllabus for WT2020 | 5 days ago |

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

2  [0 - Syllabus \(TU Darmstadt 11-2020\).pdf](#)

0 - Syllabus (TU Darmstadt 11-2020).pdf


- Click on the file you want to download



master AIAgorithmsAndApplications / Lecture / 0 - Syllabus (TU Darmstadt 11-2020).pdf Go to file

dominikjung42 updated syllabus for WT2020 Latest commit c3d2300 5 days ago History

1 contributor

2.86 MB

Click on "Download" 3 

  TECHNISCHE UNIVERSITÄT DARMSTADT
WIRTSCHAFTS

Teaching Material Icons



Important note



Definition



Referenced package/library



Referenced handout



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



Classroom question or task



Problem / Solution



Pro / Contra



Weblink or external resource

Types of Tasks and Exercises

Classroom Task



Classroom task

Your turn!

Task Please use the `str()` function to investigate the `cars` dataset. How many rows and columns does it have. Use the `isnumeric()` function, if you are not sure how to use the commands.

Task Please, try to retrieve the following values from the `cars` dataset:

- Return observations where the speed is bigger than 20
- Exclude observations 10-13 from the dataset
- Return only observations with speed bigger than 10 and smaller than 20

Decision Support Systems and Business Analytics
with R by Dominik Jung

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

Classroom Case



Business Case

Task The *Junglvet* Whisky Company is interested in the geographical and spatial distribution of the Whisky market in Scotland. They plan to put the new 10 years Junglvet on the market. He is very body and smoky. For that purpose cluster the whiskies and find the most body and smoky group of whiskies. And plot them with ggplot on a map of Scotland to support the marketing and sales team. Try to structure your work according to the process model from the lecture. Before you build the cluster, try to understand the data. Please take a look if it is true that the most smoky and body Whisky distilleries are from Islay. Use the `whiskies.csv` file for your analysis.

Decision Support Systems and Business Analytics
with R by Dominik Jung

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

Challenge / Capstone



Case Challenge

Case The sinking of the RMS Titanic is one of the most infamous shipwrecks in history. On April 15, 1912, during her maiden voyage, the Titanic sank after colliding with an iceberg, killing 1502 out of 2204 passengers and crew. This sensational tragedy shocked the international community and led to better safety regulations for ships. One of the reasons that the shipwreck led to such loss of life was that there were not enough lifeboats for the passengers and crew. Although there was some element of luck involved in surviving the sinking, some groups of people were more likely to survive than others, such as women, children, and the upper-class. In this challenge, we ask you to complete the analysis of what sorts of people were likely to survive. In particular, we ask you to apply the tools of machine learning to predict which passengers survived the tragedy.

Spruce Cartoons

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

Business Case



Business Case: Sentinel Program

01 Executive Summary
Virtual Case File for 1071 with a software application developed by the FBI between 2000 and 2005. The project was not close to completion when it was officially abandoned in January 2005, having turned into a complete fiasco for the FBI. In addition to wasting at least \$120 million, the Sentinel Program entangled numerous FBI agents and FBI analysts. Robert J. Mueller Jr. finally, \$120 million dollars were wasted on the first two attempts of the project (SIP + Sentinel) and a similar was found.

02 Solution
• Sentinel Team was set up near the product owner in the basement of the Hoover Building
• Staff reduced from 400 to 45, and in 1 year and 200 million, they were code complete. At a cost savings of more than 90 percent.

03 Takeaways
• All project management gets things done
• Agile development is cheaper

04 Introduction
Who Killed the Virtual Case File?
https://www.spectrum.com/story/2016/01/20/who-killed-the-virtual-case-file/

- Typical business case
- Discussed together

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 business analytics problems.
- 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 exist 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

Artificial 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.)

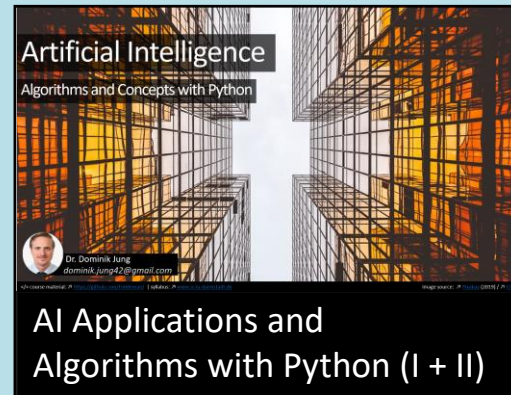
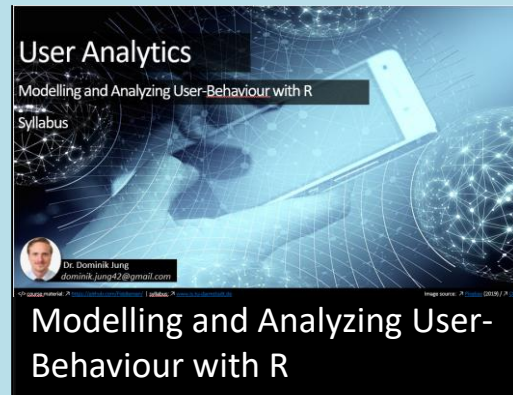


Grading (preliminary)

| Contact | Description | Distribution |
|--|--|--------------|
| Exam <i>Dr. Dominik Jung</i> | 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 <i>Timo Sturm</i> | 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!

Data Science Lectures



Data Science Seminars



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

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 and no deep shit ;)
- I also can recommend to take a look at the GIT guide from *kbroman* (↗ kbroman.org)