



Artificial Intelligence

Algorithms and Applications with Python

Syllabus



Dr. Dominik Jung
dominik.jung@jung-isec.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,
Imenau University of Technology

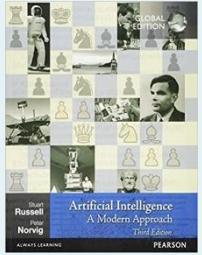
RESEARCH INTERESTS

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

Further Questions?

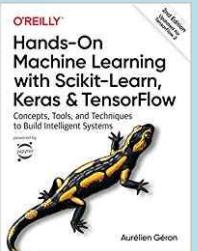
Please send me an email at
dominik.jung42@jung-isec.com

Relevant Literature



Russell, S., & Norvig, P. *Artificial Intelligence: A Modern Approach*. Global Edition.
Main course book, relevant for all chapters

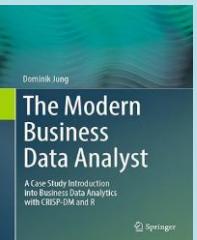
- ▶ Availability: ↗[University Library Darmstadt](#) | ↗[Amazon](#)



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](#)

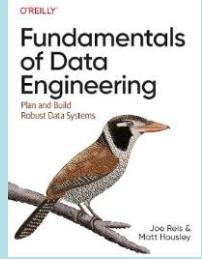


Jung, D. *The Modern Business Data Analyst: A Case Study Introduction into Business Data Analytics with CRISP-DM and R*

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

- ▶ Availability: ↗[Amazon](#)

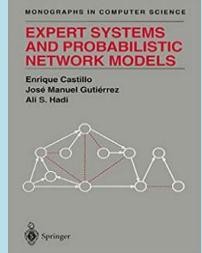
Further Literature



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](#)

Artificial Intelligence: A Modern Approach

Article Talk

⋮A 10 languages

Read Edit View history Tools

From Wikipedia, the free encyclopedia

Artificial Intelligence: A Modern Approach (AIMA) is a university textbook on [artificial intelligence](#) (AI), written by [Stuart J. Russell](#) and [Peter Norvig](#). It was first published in 1995, and the fourth edition of the book was released on 28 April 2020.^[1]

AIMA has been called "the most popular artificial intelligence textbook in the world",^[2] and is considered the standard text in the field of AI.^{[3][4]} As of 2023, it was being used at over 1500 universities worldwide,^[5] and it has over 59,000 citations on [Google Scholar](#).^[6]

AIMA is intended for an undergraduate audience but can also be used for graduate-level studies with the suggestion of adding some of the primary sources listed in the extensive bibliography.^[citation needed]

Content [edit]

Artificial Intelligence: A Modern Approach

The image shows the front cover of the first edition of the book 'Artificial Intelligence: A Modern Approach' by Stuart Russell and Peter Norvig. The cover is dark red with the title in white. Below the title is a photograph of a computer monitor displaying a windowed operating system interface, with several books and papers scattered around it. The authors' names are at the bottom, along with the publisher information: 'Prentice Hall Series in Artificial Intelligence'.

First edition (1995)

Artificial Intelligence: Algorithms and Applications with Python - Dr. Dominik Jung

7

The screenshot shows the Open Syllabus Explorer website for Computer Science. It features a sidebar with a 'FIELDS' button and a main content area with a 'Top Ranked' section. The section lists five books with their titles, authors, appearances, and scores. To the right is a map of North America showing the number of unattributed syllabi for each country. Below the map is a bar chart titled 'Top Titles by Year'.

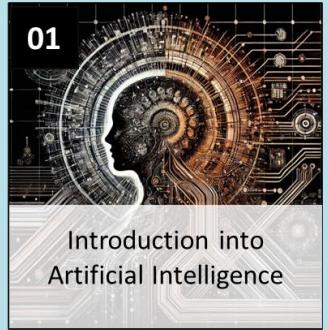
Rank	Title	Author	Publisher	Appearances	Score
1	Introduction to Algorithms	Thomas H. Cormen	MIT Press, 1990	4,548	99
2	Fundamentals of Database Systems	Ramez Elmasri	Multiple Editions	3,933	98
3	Operating System Concepts	Abraham Silberschatz	Multiple Editions	3,926	97
4	Computer Networking: A Top-Down Approach Featuring the Internet	James F. Kurose	Pearson / Addison Wesley, 2000	3,792	97
5	Computer Networks	Andrew S. Tanenbaum	Pearson / Prentice Hall, 1981	3,685	98

Map: 18,936 unattributed
Canada: 12,862
United States: 121,045

Top Titles by Year: 36,396 unattributed
Normalized

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](#)).

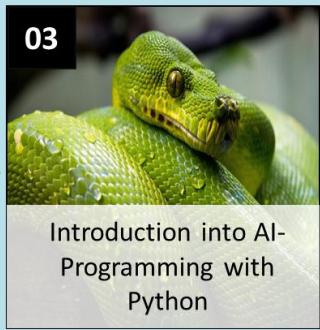
Syllabus



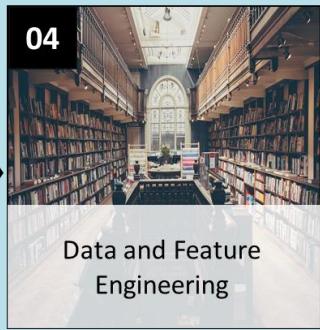
Introduction into
Artificial Intelligence



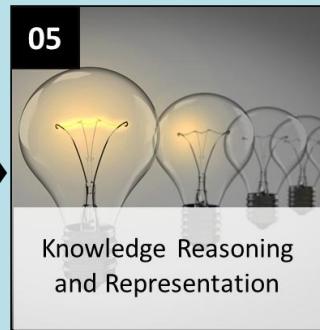
Search, Problem Solving,
and Planning



Introduction into AI-
Programming with
Python



Data and Feature
Engineering



Knowledge Reasoning
and Representation

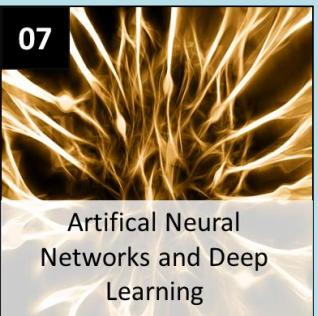


Machine Learning

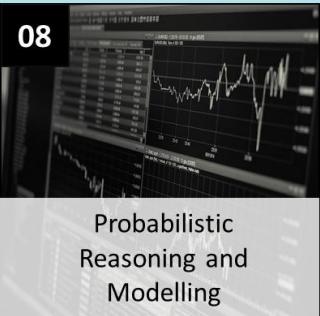
Workbook Exercises

Code Lectorial Python

Workbook & Coding Exercises



Artifical Neural
Networks and Deep
Learning



Probabilistic
Reasoning and
Modelling



Natural Language
Processing



Computer Vision



Building Productive AI-
based Information
Systems

Further units:

Live Coding Sessions

Consultation Hours

Capstone

Workbook & Coding Exercises

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

traditional
course

Lecture

Tutorial

this
course

Lecture

Capstone

Exercises /
Tutorials / Lectorials

equivalent to 27 traditional units (1 unit = 90 minutes lecture)

Lecture: on-site / online

Lectorials: online with Q&A after lecture

Exercise and Tutorials: on-site

Guiding Principle of the Course

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

Team



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



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

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



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 2025



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



TECHNISCHE
UNIVERSITÄT
DARMSTADT

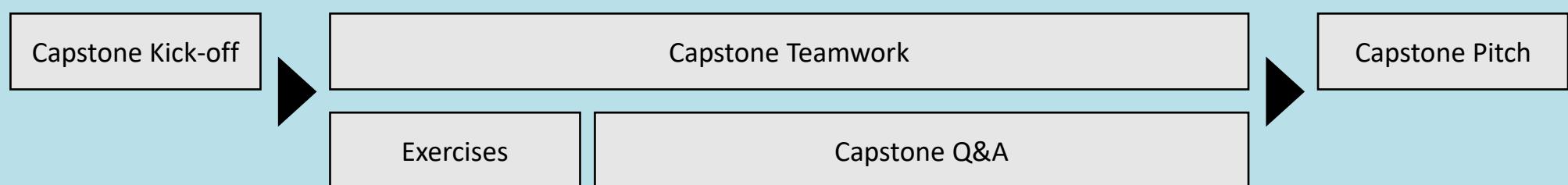
ID	Date	Start	End	Room	Chapters and Content	Lecturer
1	Fr, 17.10.	9:50	12:50	S311/0012	<ul style="list-style-type: none">▪ Syllabus▪ Ch. 1 - Introduction into Artificial Intelligence	Dr. Dominik Jung
2	Fr, 17.10.	14:25	17:55	S103/23	<ul style="list-style-type: none">▪ Ch. 2 - Search, Problem Solving, and Planning – Part 1▪ Ch. 3 - Introduction into AI-Programming with Python	Dr. Dominik Jung
3	Fr, 24.10.	9:50	12:50	S311/0012	<ul style="list-style-type: none">▪ Ch. 4 - Data and Feature Engineering with Python	Dr. Dominik Jung
4	Fr, 24.10.	14:25	17:55	S103/23	<ul style="list-style-type: none">▪ Ch. 6 - Machine Learning▪ Lectorial 1 + 2	Dr. Dominik Jung
5	Fr, 31.10.	9:50	12:50	S311/0012	<ul style="list-style-type: none">▪ Ch. 2 - Search, Problem Solving, and Planning – Part 2▪ Exercise	Dr. Timo Sturm
6	Fr, 7.11.	9:50	12:50	S311/0012	<ul style="list-style-type: none">▪ Ch. 5 - Knowledge Reasoning and Representation▪ Exercise	Dr. Timo Sturm
7	Fr, 5.12.2024	9:50	12:50	S311/0012	<ul style="list-style-type: none">▪ Ch. 6 - Machine Learning▪ Lectorial 3	Dr. Dominik Jung
8	Fr, 5.12.2024	14:25	17:55	S103/23	<ul style="list-style-type: none">▪ Ch. 7 - Artificial Neural Networks and Deep Learning▪ Ch. 8 - Probabilistic Reasoning and Modelling	Dr. Dominik Jung
9	Fr, 12.12.2024	9:50	12:50	S311/0012	<ul style="list-style-type: none">▪ Ch. 9 - Natural Language Processing▪ Ch. 10 - Computer Vision and Image Processing	Dr. Dominik Jung
10	Fr. 12.12.2024 Christmas Lecture	14:25	17:55	S103/23	<ul style="list-style-type: none">▪ Ch. 11 - Building Productive AI-based Systems▪ Course Evaluation▪ Exam Repetition	Dr. Dominik Jung

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

Outline and Organization Summer Term



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



Course Material

The screenshot shows Dominik Jung's GitHub profile. At the top, there is a navigation bar with links to Why GitHub?, Team, Enterprise, Explore, Marketplace, Pricing, a search bar, and sign-in/sign-up buttons. Below the navigation bar is a large circular profile picture of Dominik Jung standing in front of a NASA logo. To the right of the profile picture, his name "Dominik Jung" and GitHub handle "dominikjung42" are displayed, along with a "Follow" button. A bio text below states: "Data Scientist @porscheag with a keen interest in Business Analytics and Decision Support. Part-time Lecturer in". The main content area is titled "Pinned" and contains four repository cards:

- AIAlgorithmsAndApplications** (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 package, 5 stars, 9 forks.
- dstools** (Public): R-Package that contains misc functions for building and developing decision support systems with R. R package.
- NeuroIS** (Public): R-Analytics-Package for the NeuroIS Platform Brownie to analyze and investigate biophysiological and behavioural user data. R package, 1 fork.

Below the pinned repositories, there is a section showing "40 contributions in the last year" with a calendar heatmap. A callout box with an upward arrow icon contains the text: "My course materials and coding examples: www.github.com/dominikjung42/AIAlgorithmsAndApplications. Password for all secured course materials is ‘jung’".

Course Book Material

Screenshot of the GitHub organization page for **aimacode**.

The organization's profile picture features the letters "AI" and "M" in a stylized, blocky font.

aimacode
Code for the book "Artificial Intelligence: A Modern Approach"

1.9k followers | Berkeley, CA | <http://aima.cs.berkeley.edu> | peter@norvig.com

[Overview](#) [Repositories](#) 13 [Projects](#) [Packages](#) [People](#)

Popular repositories

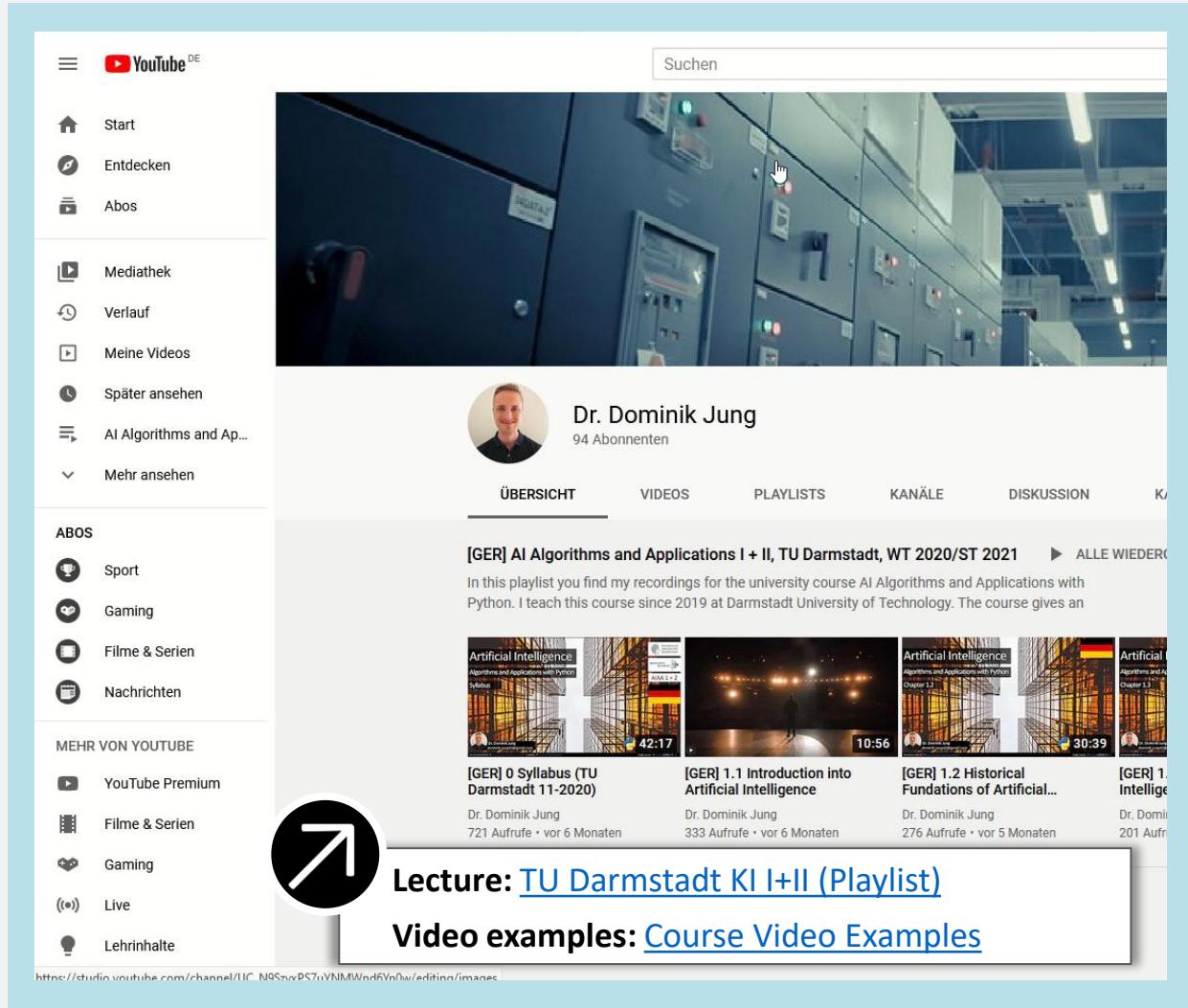
- aima-python** Public
Python implementation of algorithms from Russell And Norvig's "Artificial Intelligence - A Modern Approach"
Jupyter Notebook | 8k stars | 3.8k forks
- aima-java** Public
Java implementation of algorithms from Russell And Norvig's "Artificial Intelligence - A Modern Approach"
Java | 1.6k stars | 795 forks
- aima-exercises** Public
Exercises for the book Artificial Intelligence: A Modern Approach
HTML | 886 stars | 532 forks
- aima-pseudocode** Public
Pseudocode descriptions of the algorithms from Russell And Norvig's "Artificial Intelligence - A Modern Approach"
868 stars | 420 forks
- aima-javascript** Public
Javascript visualization of algorithms from Russell And Norvig's "Artificial Intelligence - A Modern Approach"
JavaScript | 543 stars | 218 forks
- aima-lisp** Public
Common Lisp implementation of algorithms from Russell And Norvig's "Artificial Intelligence - A Modern Approach"
Common Lisp | 101 stars | 1 fork

People
This organization has no public members. You must be a member to see who's a part of this organization.

Top languages
Python | Scala | C# | Julia | HTML

Official course book materials:
<https://github.com/aimacode/>

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.



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 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 \(427 MB\)](#)

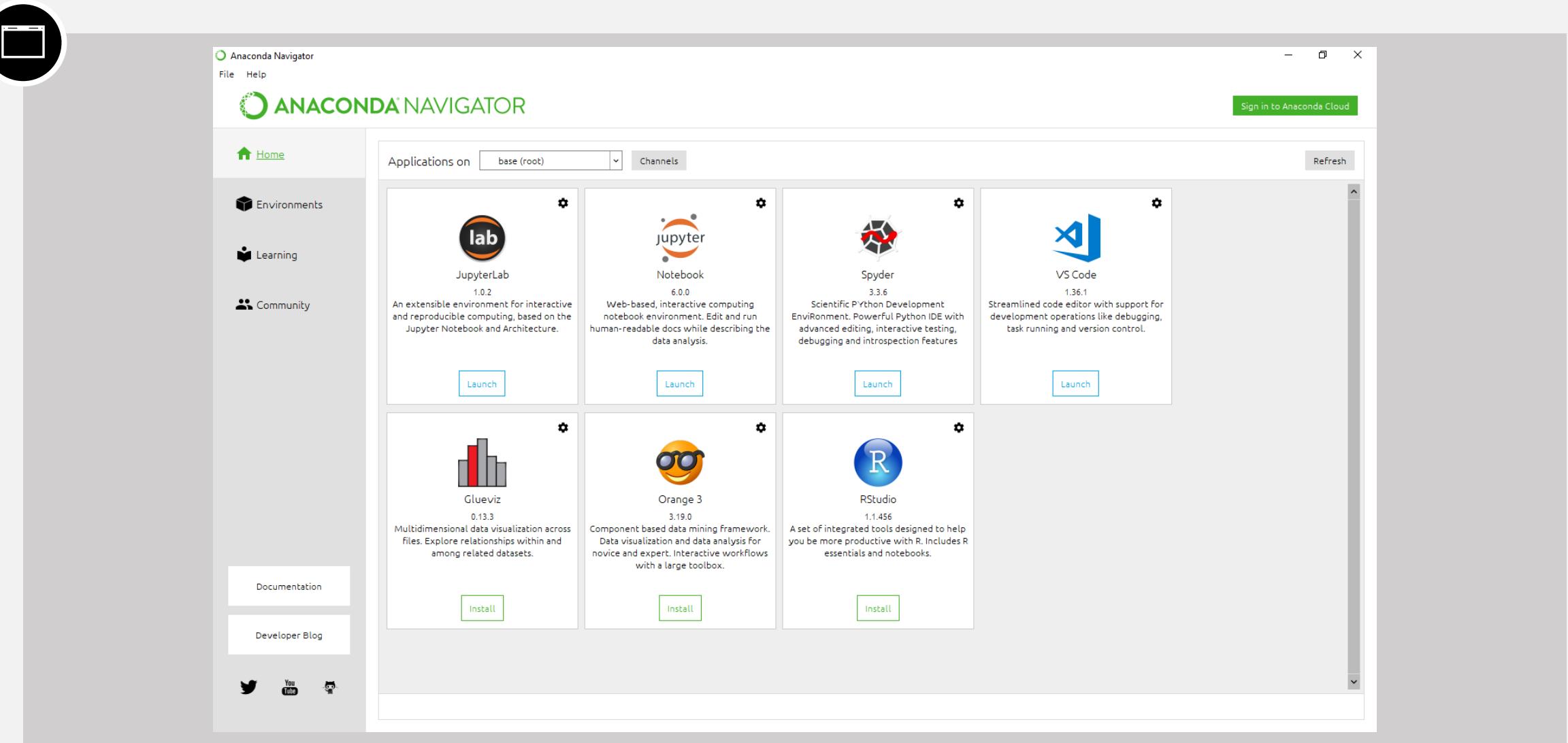
[32-Bit Graphical Installer \(361 MB\)](#)



Anaconda Platform:

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

Setup Anaconda





The screenshot shows the official Git website at <https://git-scm.com/>. The top navigation bar includes links for About, Documentation, Downloads (highlighted in red), and Community. A search bar is also present. The main content area features a large "Downloads" section with links for Mac OS X, Windows, and Linux/Unix. Below this, a note states that older releases are available and the Git source repository is on GitHub. Further down, sections for GUI Clients and Logos are shown, along with a monitor displaying the latest source release (2.23.0) and its download link.

Downloads

Mac OS X Windows
Linux/Unix

Older releases are available and the Git source repository is on GitHub.

GUI Clients

Git comes with built-in GUI tools (`git-gui`,

Logos

Various Git logos

GIT:

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

Setup GIT - Download the Course Material

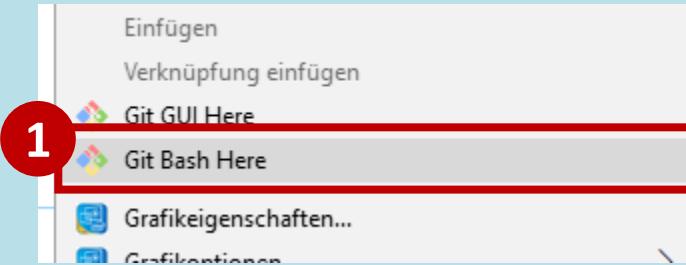
Console

- 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

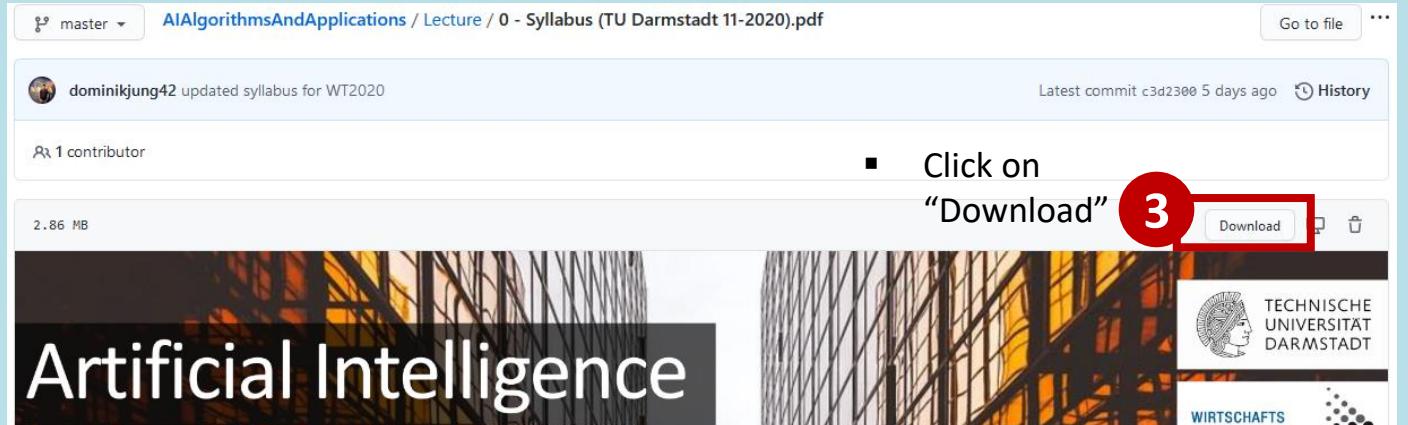
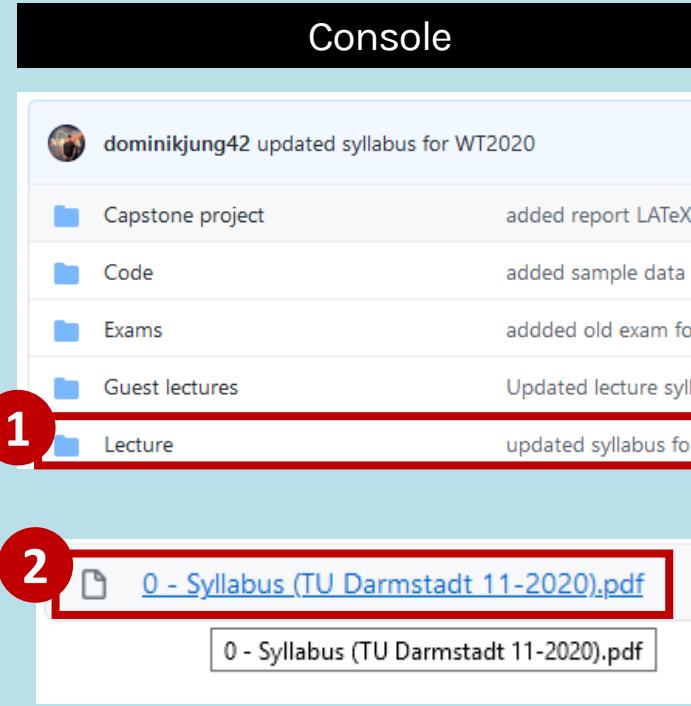
Console

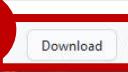
 dominikjung42	updated syllabus for WT2020	c3d2300 5 days ago	60 commits
 Capstone project	added report LATEX template	5 months ago	
 Code	added sample data files for lecture 3	20 days ago	
 Exams	added old exam for exercise	5 days ago	
 Guest lectures	Updated lecture syllabus	8 months ago	
 Lecture	updated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

1

2

3



- 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" 

Artificial Intelligence: Algorithms and Applications with Python - Dr. Dominik Jung

25

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 ressource

Types of Tasks and Exercises

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 `head(1)` 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
slide 8 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 **Junglistor Whisky Company** is interested in the geographical and spatial distribution of the whisky market in Scotland. They plan to put the new 10 years Junglistor 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 a scatterplot. You can use the `kmeans` function in R to do this. Please structure your work according the process model from the lecture. Before you built 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
slide 8 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*, after colliding with an iceberg, sank in the North Atlantic Ocean, killing nearly 1500 out of 2224 passengers and crew. This tragedy has since deeply 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 social class discrimination in the distribution of lifeboats, it is also true that women survived in greater numbers 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

Executive Summary
Virtual Case File (or VCF) was a software application developed by the FBI Laboratory. It was originally developed in 1998 and was officially obtained in January 2006, having turned into a complete dataset for the FBI. In addition to costing at least US \$20 million, the failure brought significant delays to the project. The original cost estimate was US \$10 million, but the actual cost was US \$20 million. The project was terminated in 2006, and the last version of the software was released in 2007.

Solutions
• Screen team was set up to manage the project.
• Staff reduced from 40 to 10, and a new cost of \$10 million, were code developed, at a cost savings of more than 90 percent.

References
• <http://openintivee.org/computing/influence/>
• Who Killed the Virtual Case File?

Take Action

- Typical business case
- Discussed together

Capstone Challenge @ Porsche AG (2022)



Artificial Intelligence: Algorithms and Applications with Python - Dr. Dominik Jung

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



► 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>Dr. Timo Sturm + Capstone Partners</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!

Related Courses

Data Science Lectures

Business Analytics
Business Analytics and Decision Support Systems with R
Syllabus
Dr. Dominik Jung
dominik.jung42@porsche.de

Business Analytics and Decision Support with R

User Analytics
Modelling and Analyzing User-Behaviour with R
Syllabus
Dr. Dominik Jung
dominik.jung42@gmail.com

Modelling and Analyzing User-Behaviour with R

Artificial Intelligence
Algorithms and Applications with Python
AIAA 1 + 2
The Modern Business Data Analyst
Dr. Dominik Jung
dominik.jung42@gmail.com

AI Applications and Algorithms with Python (I + II)

Data Science Seminars

Seminar
Web and Media Analytics with Python and R
Syllabus
Dr. Dominik Jung
dominik.jung42@gmail.com

Web and Media Analytics with Python and R

Seminar
Data Design and Visualization with R and Inkscape
Syllabus
Dr. Dominik Jung
dominik.jung42@gmail.com

Data Design and Visualization with R and Inkscape



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

Main literature

1. Russell, 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](https://git-scm.com)).
- *Rogerdudler Git Tutorial* ([↗ https://rogerdudler.github.io/git-guide](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](https://kbroman.org)).