Syllabus: Machine Learning using Python: Theory and Application

TU Berlin Winter University Online 2021

Course Instructor: Dennis Grinwald, Sascha Lange
Location: Online Course at Technical University Berlin
Meeting Times: Mondays through Fridays, 9:00am - 2:00 pm, January 11th – 29th, 2021
(exact times to be confirmed upon the close of registrations)

Key to Learning Formats

Lecture	Group Work	Practical	Independent Study	Assessment	Orientation or Cultural Program Session

Week 0: 04th-08th January

The items in this table are the learning activities to be completed by participants ahead of the start of the course on the 11th. All activities in week 0 are to be completed on-demand at your own pace. Access to the learning materials in the shared nextcloud folder for week 0 will be made available to you on Monday the 04th of January.

Activity Information	Details	Access Information
Pre-course reading A 2 hours	This reading will give you the background needed before the course.	NextCloud: *Course_Materials/week00/*
Pre-course Reading B 2 hours	This reading will give you the background needed before the course.	NextCloud: *Course_Materials/week00/*
Quiz A 1 hour	This online quiz will test your knowledge on readings A-B	NextCloud: *Course_Materials/week00/*
Pre-course reading B and Installation 1 hour	This reading will give you the background needed before the course and install the software needed for the course	NextCloud: *Course_Materials/week00/*
Research Task 2 hours	Prepare a topic title for a proposal based on your reading and area of interest	NextCloud: *Course_Materials/week00/*

Program Orientation Session Thursday 4th January: time will be announced Live Webinar (or watch on-demand from 5pm CET) 2 hours	Introduction to the TU Berlin, the program and to the team!	Zoom Link will be announced closer to the program start Nextcloud Folder: "Orientation" • Pdf student handbook • Recording of intro session available in folder from 5pm

Week 1: 11th- 15th January

The timetable for week 1 is below. Please note that some sessions are provided to the whole class, while some are provided to time-zone groups. Please double check which time-zone group you belong to, and attend the relevant session accordingly. Some times and zoom links will be made available closer to the start date.

Date	Session Information	Details	Access Information	Bring-to-class
Monday, January 11th	**Introduction to the course** Time CET: 09:00 11:00am Live/On-Demand: Live Format: Live Lecture	Live introduction presentation for the course and introductions to classmates.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	Prepared to give an introduction about yourself to share with class.
	Individual Study: Lecture 1 - Mathematics for ML Duration: 4h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day01/lecture/*	
	Individual Study: Exercise 1 - Mathematics for ML Duration: 2h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day01/exercises/*	
Tuesday, January 12th	**Recap Lecture 1:** Time CET: 9:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 1: Time CET: 11:00am - 12:30pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help

		supervise you working on the exercises.		you more efficiently if you have worked on the exercises beforehand.
	Individual Study: Lecture 2 - NumPy and Pandas Basics Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day02/lecture/*	
	Individual Study: Exercise 2 - NumPy and Pandas Basics Duration: 1h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day02/exercises/*	
Wednesday, January 13th	**Solutions Exercise 1:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Recap Lecture 2: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 2: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion Duration: 1.5h	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.
	Cultural Program Session Time CET: ~~3-4pm~~ Live/On-Demand: Live Format: Interactive	Historical and cultural input to your academic experience by introducing you to some of what the city of Berlin has to offer.	Zoom Link will be announced closer to the program start	
	Individual Study: Lecture 3 - Supervised Learning	Listen to the recorded lectures for the day	**Materials:** NextCloud:	

	I: Regression and Optimization Duration: 2h	online and finish the mini quiz after the lecture.	*Course_Materials/day03/lecture/*	
	Individual Study: Exercise 3 - Supervised Learning I: Regression and Optimization Duration: 1h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day03/exercises/*	
Thursday, January 14th	**Solutions Exercise 2:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Recap Lecture 3: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 3: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.
	Individual Study: Lecture 4 - Supervised Learning II: Classification Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day04/lecture/*	
	Individual Study: Exercise 4 - Supervised Learning II: Classification Duration: 1h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day04/exercises/*	
Friday, January 15th	**Solutions Exercise 3:**	In this session, the lecturer will present and	**Zoom Join Link:**	You should have your solutions

	Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	discuss the solutions for the previous exercise.	Tba: Lecturer's Meeting Room	and any questions for the exercise ready.
	Recap Lecture 4: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 4: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.
	Individual Study: Lecture 5 - Feature Engineering and evaluation techniques Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day05/lecture/*	
	Individual Study: Exercise 5 - Feature Engineering and evaluation techniques Duration: 1h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day05/exercises/*	

Week 2: 18th- 22nd January

Date	Session Information	Details	Access Information	Bring-to-class
Monday, January 18th	**Solutions Exercise 4:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.

	Recap Lecture 5: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 5: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.
	Individual Study: Lecture 6 - Supervised Learning III: Advanced regression and classification algorithms Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day06/lecture/*	
	Individual Study: Exercise 6 - Supervised Learning III: Advanced regression and classification algorithms Duration: 2h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day06/exercises/*	
Tuesday, January 19th	**Solutions Exercise 5:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Recap Lecture 6: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about

				any open/unclear topics.
	Practical Session 6: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.
	Individual Study: Lecture 7 - Unsupervised Learning I: Clustering Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day07/lecture/*	
	Individual Study: Exercise 7 - Unsupervised Learning I: Clustering Duration: 2h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day07/exercises*	
Wednesday, January 20th	**Solutions Exercise 6:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Recap Lecture 7: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 7: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on

				the exercises beforehand.
	Cultural Program Session Time CET: 1pm-2pm Live/On-Demand: Live Format: Interactive	Historical and cultural input to your academic experience by introducing you to some of what the city of Berlin has to offer.	Zoom Link will be announced closer to the program start	
	Individual Study: Lecture 8 - Unsupervised Learning II: Dimensionality Reduction Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day08/lecture/*	
	Individual Study: Exercise 8 - Unsupervised Learning II: Dimensionality Reduction Duration: 2h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day07/exercises/*	
Thursday, January 21st	**Solutions Exercise 7:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Recap Lecture 8: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 8: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.

	Project Introduction Live/On-Demand: Live Time CET: 1:00 – 2:30pm Format: Lecture	The project for the course will be introduced. We will discuss the demands and any other questions you might have. We will also form groups for the project.	**Zoom Join Link:** Tba: Lecturer's Meeting Room **Materials:** NextCloud: *Course_Materials/project/*	
	Individual Study: Lecture 9 - Neural Networks I: MLP Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day09/lecture/*	
	Individual Study: Excercise 9 - Neural Networks I: MLP Duration: 2h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day09/exercises/*	
Friday, January 22nd	**Solutions Exercise 8:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Practical Session Lecture 9: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 9: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.
	Individual Study: Lecture 10 - Neural Networks II: CNNs and RNNs Duration: 2h	Listen to the recorded lectures for the day online and finish the mini quiz after the lecture.	**Materials:** NextCloud: *Course_Materials/day10/lecture/*	

	Individual Study: Excercise 10 - Neural Networks II: CNNs and RNNs Duration: 2h	Work on the exercises for the day on your own. The lecturer will not be online, but you can post questions in the course forum.	**Materials:** NextCloud: *Course_Materials/day10/exercises/*	

Week 3: 25th- 29th January

Date	Session Information	Details	Access Information	Bring-to-class
Monday, January 25th	**Solutions Exercise 9:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Recap Lecture 10: Time CET: 10:00-11:00am Format: Live Lecture/Discussion	In this session, students can ask questions about the previous lecture. We will discuss topics not clear as a group.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have listened to the previous recorded lectures before this session and ask questions about any open/unclear topics.
	Practical Session 10: Time CET: 11:30am - 1:00pm Format: Live Lecture/Discussion	In this session, the students should work on the exercises of the previous lecture. The lecturer will be online and supervise you working on the exercises.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	It is not necessary to have worked on the previous exercise, but it is encouraged. The lecturer can help you more efficiently if you have worked on the exercises beforehand.
	Individual Study: Project Duration: 2h	Use this time to work on your project.		
Tuesday, January 26th	**Solutions Exercise 10:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will present and discuss the solutions for the previous exercise.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You should have your solutions and any questions for the exercise ready.
	Exam Preparation:	In this session the exam topics will be discussed,	**Zoom Join Link:** Tba: Lecturer's Meeting Room	Bring any questions about

	Time CET: 10:00-11:00am Format: Live Lecture/Discussion	and students can ask questions.		the exam to the class.
	Individual Study: Project/Exam Duration: 2h	Use this time to work on your project or prepare for the exam.		
Wednesday, January 27th	**Practical Session Project/Exam:** Time CET: 09:00am-10:00am Format: Live Lecture/Discussion	In this session, the lecturer will discuss any open questions for the exam or project.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	Bring any questions you have related to the exam or project to class
	Guest Lecture Time CET: 10:00-12:00pm Format: Live Lecture	A guest lecture will be presented. The lecturer is still to be announced.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	
	Individual Study: Project/Exam Duration: 3h	Use this time to work on your project or prepare for the exam.		
Thursday, January 28th	**Online Test** Time CET: 9:00-12:00pm Live/On-Demand: Live Format: Lecture	In this lecture, we will hold the online test. You will need to be on the Zoom meeting with your camera on, to verify that you are taking the test.	**Zoom Join Link:** Tba: Lecturer's Meeting Room	
	Individual Study: Project/Exam Duration: 3h	Use this time to work on your project.		
Friday, January 29th	**Project Discussion/ Presentations** Time CET: 08:30am-10:30am Live/On-Demand: Live Format: Lecture	Your project group will give a short presentation on their project and answer questions from the lecturer	**Zoom Join Link:** Tba: Lecturer's Meeting Room	You will need to have your project done and ready to present.
	Hot Topics in AI Time CET: 10:30-12:00pm Live/On-Demand: Live	As a class we will discuss some current hot topics in the field of Artificial Intelligence,	**Zoom Join Link:** Tba: Lecturer's Meeting Room	Please bring some cool topics to the discussion, which we can discuss as a group

	Format: Lecture	robotics, bioinformatics etc.		
	Feedback and Outro Time CET: 12:30-14:00pm Live/On-Demand: Live Format: Lecture	Final Lecture, in which the students can give feedback to the entire course and discuss how to continue to use ML.	**Zoom Join Link:** Tba: Lecturer's Meeting Room,	Please bring some ideas on how to improve the lecture or share things you liked!

Software

NextCloud: Access to the NextCloud learning platform will be provided to participants on Monday the 4th of January, via email.

Zoom: You will need to have a free zoom account set up ahead of the course, in order to join the live sessions during the course. You will be provided with additional instructions ahead of the course.

Other Software: You will need to install the program Anaconda with Python 3: https://www.anaconda.com/products/individual

Assessment information

You will be assessed in the following ways (see yellow sessions in schedule, if applicable):

- Online test, on *Thursday, January 28th*
- Group project and presentation, due *Friday, January 29th*

Your assessments will be weighted as follows:

- 10%: Participation (online attendance)
- 40%: Projects (components total)
- 50%: Online Final Exam

Grading information

All participants of the TU Berlin Summer & Winter University are required to select their grading option at the time of registration. The two options available are (i) graded or (ii) pass/fail.

All participants who select option (i) graded, will receive a grade under the German grading system. The following table provides an overview of the grading system and equivalent scores for international credit transfers:

Total mark	German grade	English description
More or equal to 95	1,0	Excellent
More or equal to 90	1,3	Very good
More or equal to 85	1,7	Good
More or equal to 80	2,0	Good
More or equal to 75	2,3	Good
More or equal to 70	2,7	Satisfactory
More or equal to 65	3,0	Satisfactory
More or equal to 60	3,3	Satisfactory
More or equal to 55	3,7	Sufficient
More or equal to 50	4,0	Sufficient
Less than 50	5,0	Failed

Credit Points

ECTS is a point system and European standard developed by the Commission of the European Community. ECTS stands for European Credit Transfer System. The aim is to provide common procedures and guarantee academic recognition of studies abroad. The credit system is based on student workload. All lectures, homework and group assignments count towards the workload. One point is awarded for the equivalent of 25-30 hours of workload.

Allocation of workload and ECTS

Video lectures and task in the prep week	10 hours
Online orientation + cultural program	06 hours
Live sessions	44 hours
Project work	15 hours
Self-study	48 hours
Final Exam/ Project presentation	02 hours
Total	**125 hours**
25 hours ≙ 1 Credit	**⇒ 5 Credits**