Friedrich-Alexander-Universität
Erlangen-Nürnberg

Module description

for the degree programme

Bachelor of Science
Artificial Intelligence

(Version of examination regulation: 20242)

for the winter term 2025/2026

Please note:
As the BSc AI started in the winter semester 24/25, not all modules are offered yet. The modules of the higher semesters will be added over time.

Table of contents

1	**Module name** 47598	**Algorithms, programming, and data representation**	**10 ECTS**
2	Courses / lectures	Vorlesung: Algorithms, programming, and data representation (4 SWS) Übung: Algorithms, programming, and data representation; Computer Exercise (2 SWS) Übung: Algorithms, programming, and data representation; Exercise (2 SWS) No. Lectures will be hybrid and recorded. Tutorials and Q&A will be on the MS Teams Module Lab queue.	5 ECTS 2,5 ECTS 2,5 ECTS
3	Lecturers	Prof. Dr. Bernhard Kainz Felix Nützel	

4	**Module coordinator**	Prof. Dr. Bernhard Kainz
5	**Contents**	The lecture Algorithms, programming, and data representation is aimed at students with tech and math background and is one of the basic lectures in the field of computer science. In addition to an introduction to fundamental algorithms, (object-oriented) programming in Python, various data structures such as linked lists, trees and graphs are covered. Algorithms include recursion, sorting methods and graph algorithms, as well as O notation of algorithms. Topics: • Programming and computing basics • Data structures • Object orientation • Python basic knowledge • Computational Complexity • Basic algorithms Students will solve object-oriented programming tasks in the Python programming language illustrate program structures with the help of a subset of the Unified Modelling Language compare the efforts of different algorithms in terms of runtime and memory requirements implement basic combinatorial algorithms, especially search and sort algorithms, binary trees and basic graph algorithms understand and use recursion as a link between mathematical problem descriptions and programming implementation translate recursive problem descriptions into iterative ones plan and process programming tasks in such a way that they are completed on time. Syllabus: (L - lecture, C - coursework, T - tutorial) L01 Motivation and Logistics L02 Introduction: What does a Computer do C01 Explore local Anaconda and Google Colab L03 Data Representation and Boolean Algebra

		L04 Floating Point numbers T01 Organization and Boolean Algebra C02 Number Representations and Boolean Algebra in Python L05 Memory Organisation L06 Branching and Iterations T02 Number Representations and Boolean Algebra C03 Branching and Iterations L07 Decomposition, Abstraction, and Functions, Tuples, Lists, etc. L08 Recursion and Dictionaries T03 Memory Organisation C04 Recursion and Dictionaries L09 Testing, Debugging, Exceptions, and Assertions L10 Object Oriented Programming T04 Decomposition, Abstraction, and Functions C05 Testing, Debugging, Exceptions, and Assertions L11 Classes and Inheritance L12 Program efficency I T05 Recursion C06 Classes and Inheritance L13 Program efficency II L14 Searching and Sorting T06 Object Oriented Programming C07 Searching and Sorting L15 Version management and git L16 API and Libraries T07 Program efficency C08 APIs and Libraries L18 Graphs and graph algorithms L19 Bellman-Ford T08 Searching and Sorting C09 Searching and Sorting L20 Dijkstra L21 Graphs and Trees T09 Graphs and Trees C10 Graphs and Trees L21 Dynamic Programming L22 Hashtables T10 Hashtables C11 Hashtables R01 Revision Q&A R02 Revision Q&A

6	**Learning objectives and skills**	The students will be able to • organize themselves independently into groups and coordinate the organizational and technical process of group work in consultation with each other • communicate and jointly develop solutions for theoretical questions and practical programming tasks within the framework of group tasks • plan and apply targeted measures for mutual quality assurance of the submitted solutions (check each other's group submissions) • jointly take responsibility for the result of their group work, the evaluation of which applies equally to both group partners
7	**Prerequisites**	None
8	**Integration in curriculum**	semester: 1
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Tutorial achievement Written examination (120 minutes) Graded examination achievement (Prüfungsleistung): Written examination (120 min) Ungraded course achievement (Studienleistung): weekly submission of exercises; at least 50% of total points required to pass
11	**Grading procedure**	Tutorial achievement (pass/fail) Written examination (100%) Written examination (100%)
12	**Module frequency**	Only in winter semester
13	**Workload in clock hours**	Contact hours: 120 h Independent study: 180 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english
16	**Bibliography**	• John V. Guttag: Introduction to Computation and Programming Using Python, third edition: With Application to Computational Modeling: With Application to Computational Modeling and Understanding Data • Cormen TH, Leiserson CE, Rivest RL, Stein C. Introduction to algorithms. MIT press; 2022 Apr 5. • Sedgewick R, Wayne K. Algorithms: Part I. Addison-Wesley Professional; 2014 Feb 1.

1	**Module name** 92401	**Data Engineering**	**5 ECTS**
2	Courses / lectures	No teaching units are offered for the module in the current semester. For further information on teaching units please contact the module managers.	
3	Lecturers	-	

4	**Module coordinator**	Prof. Dr. David Blumenthal
5	**Contents**	**The following topics will be covered in the lectures:** • Fundamental data modalities and how to store them (2 units), • basics of relational databases (3 units), • basics of graph databases (3 units), • proximity, distance, and correlation measures (2 units), • modalities of data bias (1 unit), • data cleaning, normalization, and integration (2 unit), • normality and outlier detection (1 unit). **The exercise covers the contents of the lectures and additionally teaches hands-on data-engineering-related skills with a special focus on Python:** • Data handling with numpy and pandas, • data visualization with seaborn and matplotlib.
6	**Learning objectives and skills**	Students will • get familiar with the fundamentals of relational and graph databases. • learn basic techniques for exploratory data analysis and data pre-processing, and data visualization. • learn how apply the covered concepts using the programming language Python.
7	**Prerequisites**	Recommended: • Algorithms, programming, and data representation (AlgProgDat) • Mathematics for Data Science 1 (MDS1)
8	**Integration in curriculum**	semester: 2
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Written examination (90 minutes) Written examination (90 min).
11	**Grading procedure**	Written examination (100%) Written examination (100%).
12	**Module frequency**	Only in summer semester
13	**Workload in clock hours**	Contact hours: 60 h Independent study: 90 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english

16	**Bibliography**	• Han, Kamber, & Pei (2012), Data Mining: Concepts and Techniques, Morgan Kaufmann. • https://www.pearson.de/first-course-in-database-systems-a-9781292025827 • https://link.springer.com/book/10.1007/978-3-319-14142-8

1	**Module name** 92403	**Computational Complexity**	**7,5 ECTS**
2	Courses / lectures	Vorlesung: Computational Complexity Lecture (4 SWS) Übung: Computational Complexity Exercise (2 SWS)	5 ECTS 2,5 ECTS
3	Lecturers	Erik Gösche Prof. Dr. Florian Knoll	

4	**Module coordinator**	Prof. Dr. Florian Knoll
5	**Contents**	The following topics will be covered: • Regular languages: Finite automata, Nondeterminism, Regular expressions, Pumping Lemma • Context-free languages: Context-free grammars, Pushdown automata, Pumping Lemma • Church-Turing thesis, Turing machines • Decidability, undecidability, reducibility • Time complexity, asymptotic notation, Classes P and NP, NP-completeness, Cook-Levin theorem • Space complexity, PSPACE, Savitch's theorem, PSPACE-completeness, games, generalized geography, Classes L and NL • Hierachy theorems, provably intractable problems, Oracles • Probabilistic algorithms, interactive proof systems In the homework assignments, students will prove small propositions using the concepts covered in the lecture. The solutions to the assignments will be discussed in the exercises.
6	**Learning objectives and skills**	Students will • Learn to use computational models to answer questions on computability and complexity • Develop fundamental skills about the limits of computability • Learn methods to proof that certain computations cannot be solved or solved in reasonable time • Develop fundamental knowledge about proof- and analysis techniques in theoretical computer science
7	**Prerequisites**	Recommended: • Mathematics for Data Science 1 and 2 (MDS1, MDS2) • Algorithms, programming, and data representation (AlgProgDat)
8	**Integration in curriculum**	semester: 3
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Written examination (90 minutes) Written exam (90mins) about the content covered in the lecture and the exercises
11	**Grading procedure**	Written examination (100%) Written examination (100%) Bonus points can be obtained by calculating homework exercises at the board during the exercise

12	**Module frequency**	Only in winter semester
13	**Workload in clock hours**	Contact hours: 90 h Independent study: 135 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english
16	**Bibliography**	• Sipser, Michael. Introduction to the Theory of Computation. • John Hopcroft and Jeffrey Ullman. Introduction to Automata Theory, Languages and Computation.

1	**Module name** 93097	**Einführung in das Software Engineering** Introduction to software engineering	**5 ECTS**
2	Courses / lectures	Vorlesung: Introduction to Software Engineering Übung: Introduction to Software Engineering Exercises - PG6 Übung: Introduction to Software Engineering Exercises - PG3 Übung: Introduction to Software Engineering Exercises - PG5 Übung: Introduction to Software Engineering Exercises - PG2 Übung: Introduction to Software Engineering Exercises - PG4 Übung: Introduction to Software Engineering Exercises - PG1	- - - - - - -
3	Lecturers	Prof. Dr.-Ing. Andreas Maier Sally Zeitler	

4	**Module coordinator**	Prof. Dr.-Ing. Andreas Maier
5	**Contents**	• Einführung in die einzelnen Phasen der Softwareentwicklung: Anforderungsanalyse, Spezifikation, Entwurf, Implementierung, Test, WartungProzessmodelle • Prozessmodelle • Agile Softwareentwicklung • Anforderungsanalyse und -verwaltung • Modellierung von Systemen (u.a. mit UML) • Software-Architekturen und Designmuster • Teststrategien • Umgang mit Software-Alterung • Projektmanagement • Software-Engineering im Bereich Machine Learning • Refactoring zur Unterstützung der Wartungsphase
6	**Learning objectives and skills**	Die Studierenden • Beschreiben Prozessmodelle und unterscheiden plangesteuerte (wie das Wasserfall- und V-Modell) und agile Prozessmodelle (wie XP, Scrum, RUP und Kanban) • Erläutern verschiedene Techniken der Anforderungsanalyse und –Ermittlung (wie Endliche Zustandsautomaten, Petri-Netze, Use Cases, User Stories) und wenden diese für plan-gesteuerte und agile Prozesse an • Stellen die Unterschiede zwischen agilem und plan-gesteuertem Requirements-Engineering dar • Verstehen und erläutern UML-Diagramme (wie Use Case-, Klassen-, Sequenz- und Kommunikationsdiagramme) und

		wenden diese auf praktische Beispiele der Objektorientierung an • Reproduzieren allgemeine Entwurfslösungen wiederkehrender Probleme des Software-Engineerings und wenden diese an • Wenden funktionale und strukturelle Testansätze an • Erklären Methoden zur Änderung und Weiterentwicklung von Software • Beschreiben Ansätze für das Projekt-Management von Softwareprojekten • Erläutern wie Methoden des Maschinellen Lernens für Software-Engineering eingesetzt werden können
7	**Prerequisites**	None
8	**Integration in curriculum**	semester: 3
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Written examination (90 minutes) Die schriftliche Prüfung enthält größtenteils Fragen im Multiple-Choice Auswahlverfahren.
11	**Grading procedure**	Written examination (100%)
12	**Module frequency**	Every semester
13	**Workload in clock hours**	Contact hours: 60 h Independent study: 90 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	german
16	**Bibliography**	• Software Engineering, Ian Sommerville, 10. Auflage, 2016 • Software-Engineering Kompakt, Anja Metzner, 2020 • Handbook of Software Engineering, Sungdeok Cha, Richard N. Taylor, Kyochul Kang (Hrsg.), 2019

1	**Module name** 65714	**Mathematics for Data Science 1** Mathematics for data science 1	**10 ECTS**
2	Courses / lectures	Übung: Special Topics in Mathematics for Engineers I (2 SWS) Vorlesung: Mathematics for Engineers I (4 SWS) Übung: Exercise Mathematics for Engineers I (2 SWS)	- - -
3	Lecturers	Dr. Shigenori Nakatsuka Dr. Yasmine Sanderson Prof. Dr. Giovanni Fantuzzi Dr. Lorenzo Liverani	

4	**Module coordinator**	Prof. Dr. Frauke Liers-Bergmann
5	**Contents**	**Foundations:** • introduction to set theory, natural, rational and real numbers • complex numbers: calculation rules and their geometric interpretation, quadratic equations **Vector spaces:** • Foundations, linear dependence, span, basis, dimension, Euclidean vector space, subspaces, affine spaces **Matrices, linear maps, systems of linear equations:** • Matrix algebra, structure of the solution sets of linear equations, Gauss algorithm, inverse matrix, linear maps, determinants, image and kernel, eigenvalues and eigenvectors, basis, least squares problems **Foundations of real analysis:** • limits, continuity, elementary functions, inverse functions
6	**Learning objectives and skills**	Students will • define and explain elementary basic calculus concepts. • learn basic structures of the number system; handling of vectors and matrices. • apply basic knowledge and techniques in calculus and reproduce fundamental principles. • collect and evaluate relevant information and recognize elementary relationships. • recognize linear relationships and treat them quantitatively and qualitatively. • explain and use solution methods for systems of linear equations. • learn basic knowledge in linear algebra, linear mappings and associated matrix calculations. • learn basic proof techniques in above-mentioned areas.
7	**Prerequisites**	None
8	**Integration in curriculum**	semester: 1
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Tutorial achievement Written examination (120 minutes)

		Graded examination achievement (Prüfungsleistung): Written examination (120 min) Ungraded course achievement (Studienleistung): Exercises (ca. 2 pages per week)
11	**Grading procedure**	Tutorial achievement (pass/fail) Written examination (100%) Written examination (100%)
12	**Module frequency**	Only in winter semester
13	**Workload in clock hours**	Contact hours: 120 h Independent study: 180 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english
16	**Bibliography**	1) Applied Linear Algebra and Matrix Analysis by Thomas S. Shores, Undergraduate Texts in Mathematics, Springer Verlag. 2) Linear Algebra by M. Thamban Nair and Arindama Singh, Undergraduate Texts in Mathematics, Springer Verlag. 3) Calculus by Jon Rogawski, W. H. Freeman and Company.

1	**Module name** 65724	**Mathematics for Data Science 2** Mathematics for data science 2	**10 ECTS**
2	Courses / lectures	No teaching units are offered for the module in the current semester. For further information on teaching units please contact the module managers.	
3	Lecturers	-	

4	**Module coordinator**	Prof. Dr. Frauke Liers-Bergmann
5	**Contents**	Calculus for functions of one real variable: • calculation rules for differentiation, mean value theorem of differential calculus, Taylor formula, • extreme values and curve discussion, Integrals for functions in one real variable: • definition of the integral and calculation rules, • differentiation, main theorem of differentiation and integration Sequences and series: • real and complex sequences of numbers, convergence: definition and theorems, sequences and series of functions, uniform convergence, power series, Fourier series, iterative solution of nonlinear equations Foundations of calculus for functions of several real variables: • limit, continuity, differentiation, partial derivative, total derivative, Taylor's theorem
6	**Learning objectives and skills**	Students will learn • handling of the differential and integral calculus of one real variable. • understanding and deciding asymptotic behavior of sequences and series, convergence concepts and calculating with these concepts. • basic properties of multidimensional functions. • basic proof techniques in above mentioned areas.
7	**Prerequisites**	Recommended: • Mathematics for Data Science 1 (MDS1)
8	**Integration in curriculum**	semester: 2
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Tutorial achievement Written examination (120 minutes) Graded examination achievement (Prüfungsleistung): Written examination (120 min) Ungraded course achievement (Studienleistung): Exercises (ca. 2 pages per week)
11	**Grading procedure**	Tutorial achievement (pass/fail) Written examination (100%) Written examination (100%).
12	**Module frequency**	Only in summer semester
13	**Workload in clock hours**	Contact hours: 120 h

		Independent study: 180 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english
16	**Bibliography**	• Calculus, Jon Rogawski, WH Freeman & Co. (2011) • Calculus II : Practice Problems, Methods, and Solutions , Rahmani-Andebili, Mehdi, Springer International Publishing (2024) • Elementary Calculus, Michael Corral, Open Textbook Library, (2020)

1	**Module name** 92405	**Artificial Intelligence Perspectives**	**5 ECTS**
2	Courses / lectures	Vorlesung mit Übung: AI Perspectives (4 SWS)	5 ECTS
3	Lecturers	Prof. Dr. Claudio Castellini Robert Richer	

4	**Module coordinator**	Prof. Dr. Claudio Castellini
5	**Contents**	The lecture AI Perspectives serves as a weekly platform for experts and decision makers from artificial intelligence, informatics and non-commercial research to give talks on their fields and views for students to not only enhance the engineer's general knowledge, but also to paint an accurate picture of the engineer's work environment in the field of future employers and are introduced to their specific requirements. Apart from a broadened horizon, insights into the interdisciplinary activities and an introduction to the region, the main goal of the event is to transmit motivation and orientation.
6	**Learning objectives and skills**	The students are familiar with possible job profiles of engineers in the field of artificial intelligence and can orientate themselves according to their own career.
7	**Prerequisites**	None
8	**Integration in curriculum**	semester: 1
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Written or oral Graded examination achievement (Prüfungsleistung): Written examination (90 min)
11	**Grading procedure**	Written or oral (100%) Written examination (100 %)
12	**Module frequency**	Only in winter semester
13	**Workload in clock hours**	Contact hours: 60 h Independent study: 90 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english
16	**Bibliography**	The Relevance of Artificial Intelligence in the Digital and Green Transformation of Regional and Local Labour Markets Across Europe - Perspectives on Employment, Training, Placement, and Social Inclusion (https://www.katalog.fau.de/TouchPoint/singleHit.do?methodToCall=showHit&curPos=6&identifier=2_SOLR_SERVER_474630890) Industry 4.0 Perspectives and Applications (https://directory.doabooks.org/handle/20.500.12854/113219)

		Multidisciplinary Perspectives on Artificial Intelligence and the Law (https://link.springer.com/book/10.1007/978-3-031-41264-6)

1	**Module name** 92406	**Artificial Intelligence Fundamentals 1**	**5 ECTS**
2	Courses / lectures	Vorlesung mit Übung: AI Fundamentals I (4 SWS)	5 ECTS
3	Lecturers	Prof. Dr. Andreas Kist	

4	**Module coordinator**	Prof. Dr. Andreas Kist
5	**Contents**	**Introduction.** Introduction to Artificial Intelligence: history, types of AI. Feature types: qualitative, quantitative, symbolic, ordinal, and categorical. Decision making of machines: feature extraction and classifiers. Intuitive approaches: separation line, separation surface. Review of fundamentals: multivariate statistics, Normal distribution. **Numerics and optimization.** Overview of linear algebra. Gradient descent and stochastic gradient descent. Linear and non-linear optimization. **Dimensionality reduction.** Overview of high-dimensional data and the curse of dimensionality. Feature selection: backward elimination. Linear methods: PCA, LDA. Nonlinear methods: kernel PCS, t-SNE.
6	**Learning objectives and skills**	Students will • learn the concepts and definitions of artificial intelligence. • compare and analyse different symbolic approaches for uninformed or informed search. • explain basic concepts of linear algebra. • explain and apply optimization algorithms. • effectively handle high-dimensional data and apply properly dimensionality reduction techniques. • enlarge their knowledge in the above mentioned topics by self-guided study of the suggested and other references.
7	**Prerequisites**	Recommended: • Mathematics for Data Science 1 (MDS1) • Algorithms, Programming, and Data Representation (AlgProgData)
8	**Integration in curriculum**	semester: 3
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Written examination (90 minutes) Written examination (90 min).
11	**Grading procedure**	Written examination (100%) Written examination (100%).
12	**Module frequency**	Only in winter semester
13	**Workload in clock hours**	Contact hours: 60 h Independent study: 90 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english

16	**Bibliography**	• Bishop, C. M. (2006). Pattern recognition and machine learning. Springer. • Russell, S. J., and Norvig, P. (2010). Artificial intelligence: a modern approach. Pearson Education, Inc.

1	**Module name** 92407	**Logic and Symbolic Artificial Intelligence**	**7,5 ECTS**
2	Courses / lectures	Vorlesung: Logic and Symbolic Artificial Intelligence, Theory (4 SWS) Übung: Logic and Symbolic Artificial Intelligence, Exercises (2 SWS)	5 ECTS 2,5 ECTS
3	Lecturers	Prof. Dr. Claudio Castellini Dr. rer. nat. Sabine Thürauf	

4	**Module coordinator**	Prof. Dr. Claudio Castellini
5	**Contents**	• Propositional Logic: syntax and semantics, expressive power and complexity, algorithms, problems, applications • First-Order Logic: syntax and semantics, expressive power and complexity, applications • A glimpse on Higher-Order and Modal Logic • Application domains: constraint-satisfaction problems; combinatorial optimisation; model checking
6	**Learning objectives and skills**	Students will • gain a broad understanding of logical languages, their fundamentals and associated problems. • gain a broad knowledge about the theoretical tools available to tackle problems in the field, and can solve them (at the B.Sc. level). • be able to formalise and, to some extent, autonomously solve, problems of symbolic AI such as, e.g., planning, CSP, etc.
7	**Prerequisites**	None
8	**Integration in curriculum**	semester: 3
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Written examination (60 minutes) Written examination (60 min).
11	**Grading procedure**	Written examination (100%) Written examination (100%).
12	**Module frequency**	Only in winter semester
13	**Workload in clock hours**	Contact hours: 90 h Independent study: 135 h
14	**Module duration**	1 semester
15	**Teaching and examination language**	english
16	**Bibliography**	• Russell, S. and Norvig, P., Artificial Intelligence: A Modern Approach. 3rd ed. Upper Saddle River, NJ, Prentice Hall, 2010.

1	**Module name** 1500	**Free Choice (B.Sc. Artificial Intelligence 20242)** Free choice (BSc Artificial Intelligence 20242)	**10 ECTS**
2	Courses / lectures	No courses / lectures available for this module! depending on the selected module	
3	Lecturers	No lecturers available since there are no courses / lectures for this module!	

4	**Module coordinator**	
5	**Contents**	In the Free Choice module group, students must select modules worth 10 ECTS credits from all modules offered by FAU. English language courses up to and including level B1+ are excluded. **Course and exam registration** • A list of the courses offered can be found on Campo in the course catalog under “Electives, soft skills and language courses” (at the top above the faculties). English language courses up to and including level B1+ are excluded. • Select your desired course, register if necessary and ask the lecturer for the examination number. • As exam registration must first be activated, please send an e-mail to study-ai-bachelor@fau.deat least 3 weeks before the start of the exam registration stating which modules (title) and exams (no.) you have chosen this semester. We will then have the exam registration activated. • If you would like to take a module that is not listed under “Electives, soft skills and language courses” in the Campo course catalog, please clarify in advance with the lecturer whether they will allow you to take it in the Free Choice section.
6	**Learning objectives and skills**	The learning outcome of this group of modules is to allow students to choose their own individual focus outside the area of artificial intelligence. The type and scope of the lectures and seminars and the examination are dependent on the skills for the chosen module according to the relevant degree program and examination regulations and the module handbook.
7	**Prerequisites**	depending on the selected module
8	**Integration in curriculum**	semester: 2
9	**Module compatibility**	Pflichtmodul Bachelor of Science Artificial Intelligence 20242
10	**Method of examination**	Variable Variable Variable Variable Variable Variable

		depending on the selected module
11	**Grading procedure**	Variable (pass/fail) Variable (pass/fail) Variable (pass/fail) Variable (pass/fail) Variable (pass/fail) Variable (pass/fail) depending on the selected module
12	**Module frequency**	no Module frequency information available!
13	**Workload in clock hours**	Contact hours: ?? h (keine Angaben zum Arbeitsaufwand in Präsenzzeit hinterlegt) Independent study: ?? h (keine Angaben zum Arbeitsaufwand im Eigenstudium hinterlegt)
14	**Module duration**	1 semester
15	**Teaching and examination language**	english
16	**Bibliography**	depending on the selected module

Application Domain Fundamentals

Students must obtain a total of 20 ECTS in the area of "Application Domain Fundamentals".

Places are allocated centrally. Please do not register directly for the modules, but indicate in an e-mail to study-ai-bachelor@fau.de which courses you would like to take this semester.
As these modules from other degree programs are also kindly offered to BSc AI students, the limited places available in the courses are allocated centrally. Please do not register directly for the courses on your own and do not take the exam if you have not been centrally assigned to a module and have taken part in the course.

1	**Modulbezeichnung** 85603	**Analysis of macroeconomic and financial markets data**	**5 ECTS**
2	Lehrveranstaltungen	Seminar: Analysis of Macroeconomic and Financial Markets Data (4 SWS)	5 ECTS
3	Lehrende	Prof. Dr. Jonas Dovern Dr. Maximilian Böck	

4	**Modulverantwortliche/r**	Prof. Dr. Jonas Dovern
5	**Inhalt**	Economic data from businesses, countries, international organizations, and international financial markets are often available as time series. This class covers the basic econometric methods that are used to analyze such data. In particular, this involves analyzing the properties of economic time series, models for trends and seasonal effects, autoregressive moving average (ARMA) models, forecasting, analyzing statistical features of financial market data, and (G)ARCH models.
6	**Lernziele und Kompetenzen**	Students are able to ... • visualize time series and to identify features such as trends or seasonal patterns; • analyze time series using ADL, ARMA and (G)ARCH models (specification, estimation, forecasting); • produce, interpret and evaluate time-series forecasts; • practically analyze data from various countries or international financial markets using the software R and to interpret regression outputs from the statistical software.
7	**Voraussetzungen für die Teilnahme**	Recommendation: Data Science: Datenauswertung and Data Science: Statistik / Statistics; Data Science: Ökonometrie / Introduction to Econometrics
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Hausarbeit/Seminararbeit First registration for the examination (project report) is only possible in the winter term! During summer terms, we offer only examination for students who were registered but failed to pass in the winter term! The project reports should be approximately 15 pages long.
11	**Berechnung der Modulnote**	Hausarbeit/Seminararbeit (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester

15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Diebold, F. X. (2007), Elements of Forecasting, 4th edition (or earlier editions), Thomson Higher Education, Mason. Verbeek, M. (2004), A Guide to Modern Econometrics, 2nd edition, John Wiley & Sons. Wooldrige, J. M. (2015). Introductory Econometrics. A Modern Approach, 6th edition (or other editions), Cengage Learning.

1	**Modulbezeichnung** 96010	**Architekturen der digitalen Signalverarbeitung** Architectures for digital signal processing	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr.-Ing. Georg Fischer
5	**Inhalt**	Inhalt: • Basis-Algorithmen der Signalverarbeitung (FFT, Fensterung, Digitale FIR- und IIR-Filter) • Nichtideale Effekte bei Digitalfiltern (Quantisierung der Filterkoeffizienten, Quantisierte Arithmetik) • CORDIC-Architekturen • Architekturen für Multiratensysteme (Abtastratenumsetzer) • Architekturen digitaler Signalgeneratoren • Maßnahmen zur Leistungssteigerung (Pipelining) • Architekturen digitaler Signalprozessoren • Anwendungen Content: • Basic algorithms of signal processing (FFT, windowing, digital FIR and IIR-filters) • Non-idealities of digital filters (quantization of filter coefficients, fixed-point arthmetic) • CORDIC-architectures • Architectures of systems with multiple sampling rates (conversion between different sampling rates) • Digital signal generation • Measures of performance improvement (pipelining) • Architecture of digital signal processors • Applications
6	**Lernziele und Kompetenzen**	Die Studierenden erlangen Grundlagenkenntnisse der Signaltheorie und können zeit- und wertkontinuierliche sowie zeit- und wertdiskrete Signale im Zeit- und Frequenzbereich definieren und erklären Die Studierenden sind in der Lage, ein klassisches Echtzeitsystem zur digitalen Signalverarbeitung konzeptionieren und die Einzelkomponenten nach den Anforderungen zu dimensionieren Die Studierenden erlangen einen Überblick über Vor- und Nachteile analoger sowie digitaler Signalverarbeitung Die Studierenden verstehen die Theorie der Fourier-Transformation und sind in der Lage, die Vorteile der Fast-Fourier-Transformation in der digitalen Signalverarbeitung zu verstehen und anzuwenden Die Studierenden können digitale Filter dimensionieren und beurteilen ===Englisch=== Students

		• can obtain fundamentals of signal theory and can define as well time-comtinous and value-continous as time-discrete and value-discrete signals in time and frequency domain • can construct a realtime digital signal processing system and dimension its components according requirements • can review pros and cons of analogue versus digitzal signal processing • can apply fourier transformation and illustrate the advantages of fast fourier transformation in the context of digital signal processing • can dimension digital filters and evaluate their performance
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	elektronische Prüfung (60 Minuten) Klausur (E-Exam 60 Min.)
11	**Berechnung der Modulnote**	elektronische Prüfung (100%)
12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 87017	**Data Collection Methods in the Social and Behavioral Sciences** Data collection methods in the social and behavioral sciences	**5 ECTS**
2	Lehrveranstaltungen	Tutorium: Tutorium zum VHB-Kurs "Data Collection Methods in the Social and Behavioral Sciences" (0 SWS) Kurs: VHB-Kurs "Data Collection Methods in the Social and Behavioral Sciences" (2 SWS)	- 5 ECTS
3	Lehrende	Dr. Karen Döring	

4	**Modulverantwortliche/r**	Prof. Dr. Klaus Moser
5	**Inhalt**	This course presents an overview of various data collection methods in the Social and Behavioral Sciences that are particularly relevant for Organizational Behavior, Consumer Behavior, and Experimental Economics, but also for the Health Sciences and Business Research. First, students learn some basics on reasons for collecting data, research designs (e.g., experiments, longitudinal studies), media (paper & pencil, reaction data, web etc.), targets (e.g., individuals, groups, organizations), and the quality of measures and data (e.g., objectivity, reliability, validity). The main part will be the presentation of data collection methods, for example observation of behavior, interviews, simulations, ratings and judgments, psychological tests (personality, competencies, intelligence, recall and recognition tests), physiological measures (e.g., skin conductance, magnetic resonance imaging), and non-reactive measures (e.g., analyzing tracking, website contents). The final part will cover basics on ethical and legal issues.
6	**Lernziele und Kompetenzen**	Students will gain an overview of methods as well as learn how to find and evaluate them. In addition, they will have some experiences with using them. One important aim is to prepare students for working on a thesis in which the collection and/or evaluation of primary data on individuals, groups, or organizations plays an important role.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Seminarleistung Klausur mit MultipleChoice seminar achievement (case study, 3-5 pages) written examination (45 minutes)
11	**Berechnung der Modulnote**	Seminarleistung (50%) Klausur mit MultipleChoice (50%)
12	**Turnus des Angebots**	in jedem Semester

13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 0 h Eigenstudium: 150 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Hoyer, W.D., MacInnis, D.J. & Pieters, R. (2016). *Consumer behavior*. Cengage Learning. (Chapter: Developing information about consumer behavior.) Bryman, A. (2016). *Social Research Methods*. Oxford: University Press.

1	**Modulbezeichnung** 87005	**Electronic Human Resource Management (e-HRM)** Electronic human resource management (e-HRM)	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung mit Übung: Electronic Human Resources Management (E-HRM) (4 SWS)	5 ECTS
3	Lehrende	Tina Wölfl Prof. Dr. Sven Laumer	

4	**Modulverantwortliche/r**	Prof. Dr. Sven Laumer Tina Wölfl
5	**Inhalt**	Die Unterlagen zur Vorlesung und Übung sind auf Englisch und Deutsch verfügbar. Agenda: • Part A: Fundamentals of strategic and electronic HRM • Part B: Social Media • Part C: Data-driven approaches and their use in HRM • Part D: Challenges and opportunities of E-HRM Der Kurs beschäftigt sich mit dem Management einer der wichtigsten Ressourcen im Unternehmen: dessen MitarbeiterInnen. Neben der Vermittlung von Grundlagen zum Human Resources Management (HRM) wird insbesondere auf den Einsatz und die Entwicklung von digitalen Technologien eingegangen und betrachtet, wie digitale Arbeitssysteme das Personalmanagement verändern. Dabei wird auf Grundlagen des strategischen und elektronischen Human Resources eingegangen und es wird der Einsatz von Social Media im HR-Bereich betrachtet. Zudem werden datengetriebene Ansätze und deren Nutzung im HR sowie Herausforderungen und Chancen von elektronischem Human Resources Management (E-HRM) diskutiert.
6	**Lernziele und Kompetenzen**	Das generelle Lern- und Qualifikationsziel des Moduls ist es, Studierende Wissen über den Einsatz und die Entwicklung von digitalen Technologien im Personalwesen erlangen, Auswirkungen digitaler Technologien auf Human Resources Management (HRM) erklären und digitale Innovationen für HRM gestalten können.
7	**Voraussetzungen für die Teilnahme**	Die Anmeldung über die vhb (www.vhb.org) ist notwendig, um Zugang zum StudOn Kurs zu erhalten.
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur Klausur (90 Minuten) Die Prüfungsleistungen sind auf Englisch und Deutsch verfügbar (Wahlfreiheit) - AUSNAHME: Rein englischsprachige Studiengänge müssen die Sprache Englisch wählen - genaueres regelt die PO des jeweiligen Studiengangs.
11	**Berechnung der Modulnote**	Klausur (100%)

12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 1 h Eigenstudium: 149 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Deutsch oder Englisch
16	**Literaturhinweise**	Wird im Kurs mitgeteilt

1	**Modulbezeichnung** 92776	**Fundamentals of electrical engineering**	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung: Fundamentals of Electrical Engineering (dummy for asynchronous, non-supervised course) (2 SWS)	5 ECTS
3	Lehrende	Hans Rosenberger	

4	**Modulverantwortliche/r**	Prof. Dr.-Ing. Ralf Müller
5	**Inhalt**	• Elektrostatisches Feld • Stationäres elektrisches Strömungsfeld • Gleichstromnetzwerke • Stationäres Magnetfeld • Zeitlich veränderliches elektromagnetisches Feld • Zeitlich periodische Vorgänge • Ausgleichsvorgänge • Halbleiterbauelemente und ausgewählte Grundschaltungen ==== • Electrostatic field • Stationary electric flow field • Direct current networks • Stationary magnetic field • Time-varying electromagnetic field • Time periodic processes • Transient processes • Semiconductor devices and selected basic circuits
6	**Lernziele und Kompetenzen**	• Die Studierenden erläutern die Grundkonzepte von elektrische Ladung und Ladungsverteilungen. Sie nutzen das Coulombsche Gesetz und analysieren die elektrische Feldstärke, berechnen das elektrostatisches Potential und die elektrische Spannung. Sie bestimmen die elektrische Flussdichte und wenden das Gaußsche Gesetz an. Die Studierenden beschreiben Randbedingungen der Feldgrößen und bestimmen den Einfluss von Materie im elektrostatischen Feld. Sie bestimmen die relevanten Größen an Kondensator und Kapazität und ermitteln den Energiegehalt des elektrischen Feldes. • Die Studierenden erläutern die Begriffe Strom und Stromdichte, sie verwenden das Ohmsche Gesetz und erläutern das Verhalten an Grenzflächen. Sie ermitteln Energie und Leistung. • Die Studierenden erläutern die Rolle von Spannungs- und Stromquellen in Gleichstromnetze. Mit Hilfe der Kirchhoffsche Gleichungen analysieren sie einfache Widerstandsnetzwerke, die Wechselwirkung zwischen Quelle und Verbraucher und allgemeine Netzwerke. • Die Studierenden erklären die Begriffe Magnetfeld und Magnete. Sie berechnen die im Magnetfeld auf bewegte Ladungen wirkenden Kräfte und die magnetische Feldstärke

durch Nutzung des Durchflutungsgesetzes. Die Studierenden erläutern die magnetischen Eigenschaften der Materie und das Verhalten der Feldgrößen an Grenzflächen. Sie ermitteln die Induktivität.

- Die Studierenden nutzen das Induktionsgesetz, bestimmen die Selbstinduktion, analysieren einfache Induktivitätsnetzwerke und ermitteln die Gegeninduktivität. Sie analysieren den Energieinhalt des magnetischen Feldes, wenden die Prinzipien der Bewegungsinduktion (Generatorprinzip) und der Ruheinduktion (Übertrager) an.
- Die Studierenden erläutern die Beziehungen zeitlich veränderlicher Ströme und Spannungen. Sie verwenden Methoden der komplexen Wechselstromrechnung um Wechselspannungen und Wechselströme zu ermitteln. Sie ermitteln und analysieren die Übertragungsfunktionen linearer zeitinvarianter Systeme. Sie analysieren Leistung und Energie in Wechselspannungsnetzen.
- Die Studierenden analysieren lineare, zeitinvariante Systeme sowie Signale in Zeit- und Frequenzbereich (Fourieranalyse). Dazu bestimmen und analysieren sie die Eigenfunktionen von LTI-Systemen und deren Übertragungsfunktionen und untersuchen Schaltungen aus LTI-Systemen.
- Die Studierenden erläutern die Grundlagen von Ausgleichsvorgängen in einfachen Netzwerken und berechnen diese bei der R-L-Reihenschaltung. Sie erläutern divergierende Fälle und untersuchen Netzwerke mit einem Energiespeicher mit Hilfe einer vereinfachten Analyse.
- Die Studierenden erläutern den Ladungstransport in Halbleitern und analysieren den pn-Übergang. Sie ermitteln Ströme und Spannungen bei den folgenden Halbleiterbauelementen: Halbleiterdiode, Z-Diode, Bipolartransistor, Feldeffekttransistor Thyristor, IG-Bipolar-Transistor.
- Die Studierenden wenden alle eingeführten Inhalte an, um selbständig einfache und dabei dennoch möglichst praxisnahe kleine Probleme systematisch zu lösen. Sie kontrollieren dabei selbst ihren Lernfortschritt und besprechen Fragen mit einem Tutoren, woraus sich Fachgespräche entwickeln, wie sie die ähnlich später in Verhandlungen und bei der Produktentwicklung mit Fachingenieurinnen und Fachingenieuren aus Elektro- und Informationstechnik führen müssen, sowie im interdisziplinären Dialog mit Elektro- und Informationstechnikern und Physikern.
- Die Studierenden erkennen die Vorzüge einer regelmäßigen Nachbereitung und Vertiefung des Stoffes, da sie in diesem Modul ein für ihr Fachstudium fremdes Gebiet kennenlernen mit einer teilweise anderen mathematischen und physikalischen Herangehensweise. Sie zeigen eine hohe

Arbeitsdisziplin, Freude am Entdecken von Neuem, aber auch eine gewisse Belastbarkeit und Leistungsbereitschaft.

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- Students explain the basic concepts of electric charge and charge distributions. They use Coulomb's law and analyze the electric field strength, calculate the electrostatic potential and the electric voltage. They determine electric flux density and apply Gauss's law. Students describe boundary conditions of field quantities and determine the influence of matter in the electrostatic field. They determine the relevant quantities at the capacitor and capacitance and determine the energy content of the electric field.
- The students explain the terms current and current density, they use Ohm's law and explain the behavior at boundaries. They determine energy and power.
- Students explain the role of voltage and current sources in DC power systems. Using Kirchhoff's equations, they analyze simple resistor networks, the interaction between source and load, and general networks.
- Students explain the terms magnetic field and magnets. They calculate the
- forces acting on moving charges in the magnetic field and the magnetic field strength by using the law of flux. Students explain the magnetic properties of matter and the behavior of field quantities at boundaries. They determine inductance.
- Students use the law of induction, determine self-inductance, analyze simple inductance networks, and determine mutual inductance. They analyze the energy content of the magnetic field, apply the principles of motion induction (generator principle) and rest induction (transformer).
- Students explain the relationships of time-varying currents and voltages. They use methods of complex numbers in AC curcuits to determine alternating voltages and alternating currents. They determine and analyze the transfer functions of linear time-invariant systems. They analyze power and energy in AC power systems.
- Students analyze linear, time-invariant systems as well as signals in time and frequency domain (Fourier analysis). For this purpose, they determine and analyze the eigenfunctions of LTI systems and their transfer functions and examine circuits from LTI systems.
- The students explain the basics of transient processes in simple networks and calculate them for the R-L series circuit. They explain divergent cases and investigate networks with an energy storage using a simplified analysis.
- Students explain charge transport in semiconductors and analyze the pn junction. They determine currents and voltages for the following semiconductor devices: Semiconductor diode,

		Z-diode, bipolar transistor, field effect transistor thyristor, IG bipolar transistor. • The students apply all introduced contents to independently and systematically solve simple and yet practical small problems. They control their learning progress themselves and discuss questions with a tutor, from which technical discussions develop, as they later have to conduct them similarly in negotiations and product development with specialist engineers from electrical and information engineering, as well as in interdisciplinary dialog with electrical and information engineers and physicists. • Students recognize the benefits of regular follow-up and consolidation of the material, since in this module they become acquainted with an area that is unfamiliar to their specialized studies, with a partially different mathematical and physical approach. They show a high level of work discipline, enjoy discovering new things, but also a certain resilience and willingness to perform.
7	**Voraussetzungen für die Teilnahme**	The students use methods of vector analysis and use Cartesian coordinates, cylindrical and polar coordinates. They solve systems of linear equations and calculate with complex numbers. They use the trigonometric formulas and solve linear ordinary differential equations with constant coefficients in transient processes. Students know and understand basic physical concepts, especially quantities and quantity equations.
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (90 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	• Manuskript zur Vorlesung / Lecture notes • ALBACH, M.: Elektrotechnik, 1. Auflage, Pearson-Studium, München, 2011. • ALBACH, M., FISCHER, J.: Übungsbuch Elektrotechnik, 1. Auflage, Pearson-Studium, München, 2012.

		• FROHNE, H. et al.: Moeller Grundlagen der Elektrotechnik, 22., verbesserte Auflage, Vieweg+Teubner Verlag, Wiesbaden, 2011. • SPECOVIUS, J.: Grundkurs Leistungselektronik: Bauelemente, Schaltungen und Systeme , 4. Auflage, Vieweg +Teubner, Wiesbaden, 2010.

1	**Modulbezeichnung** 97123	**Integrated Production Systems** Integrated production systems	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung mit Übung: Integrated Production Systems (vhb) (4 SWS)	5 ECTS
3	Lehrende	Prof. Dr.-Ing. Florian Risch Bernd Hofmann	

4	**Modulverantwortliche/r**	Prof. Dr.-Ing. Jörg Franke Prof. Dr.-Ing. Florian Risch
5	**Inhalt**	• Concepts and Success Factors of Holistic Production Systems • Production organization in the course of time • The Lean Production Principle (Toyota Production System) • The 7 Types of Waste (Muda) in Lean Production • Visual management as a control and management instrument • Demand smoothing as the basis for stable processes • Process synchronization as the basis for capacity utilization • Kanban for autonomous material control according to the pull principle • Empowerment and group work • Lean Automation - "Autonomation" • Fail-safe operation through Poka Yoke • Total Productive Maintenance • Value stream analysis and value stream design • Workplace optimization (lean manufacturing cells, U-Shape, Cardboard Engineering) • OEE analyses to increase the degree of utilization • Quick Setup (SMED) • Implementation and management of the continuous improvement process (CIP, Kaizen) • Overview of quality management systems (e.g. Six Sigma, TQM, EFQM, ISO9000/TS16949) and analysis tools for process analysis and improvement (DMAIC, Taguchi, Ishikawa) • administrative waste • Specific design of the TPS (e.g. for flexible small-batch production) and adapted implementation of selected international corporations
6	**Lernziele und Kompetenzen**	After successfully attending the course, students should be able to • Understand the importance of holistic production systems; • Understand and evaluate Lean Principles in their context; • to evaluate, select and optimise the necessary methods and tools; • To be able to carry out simple projects for the optimisation of production and logistics on the basis of what has been learned in a team.
7	**Voraussetzungen für die Teilnahme**	Keine

8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (90 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 94920	**International Supply Chain Management** International supply chain management	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung mit Übung: International Supply Chain Management (vhb) (4 SWS)	5 ECTS
3	Lehrende	Prof. Dr.-Ing. Florian Risch Adrian Peter Wolfgang Hagen	

4	**Modulverantwortliche/r**	Prof. Dr.-Ing. Jörg Franke Prof. Dr.-Ing. Florian Risch
5	**Inhalt**	Contents: The virtual course intents to give an overview on the main tasks of a supply chain manager in an international working environment: • Goals and tasks • Methods and tools • International environment • Knowledge and experience of industrial practice • Cutting edge research on SCM For practical training, 3 additional Case Studies are executed as part of the course. Lehreinheiten / Units: • Integrated logistics, procurement, materials management and production • Material inventory and material requirements in the enterprise • Strategic procurement • Management of procurement and purchasing • In-plant material flow and production systems • Distribution logistics, global tracking and tracing • Modes of transport in international logistics • Disposal logistics • Logistics controlling • Network design in supply chains • Global logistic structures and supply chains • IT systems in supply chain management • Sustainable supply chain management
6	**Lernziele und Kompetenzen**	After having completed this course successfully, the student will be able to • define the basic terms of supply chain management • understand important procurement methods and strategies • name and classify different stock types and strategies • analyse possibilities for cost reduction in supply chains • know and differentiate central IT systems of supply chain management • explain disposal and controlling strategies • recognise the main issues in international supply networks • know the possibilities of transformation to a sustainable supply chain • assess different modes of transport

7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (120 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 122337	**Magnetic Resonance Imaging** Magnetic resonance imaging	**5 ECTS**
2	Lehrveranstaltungen	Übung: Magnetic Resonance Imaging 1 - Exercise (2 SWS) Vorlesung: Magnetic Resonance Imaging 1 (2 SWS)	2,5 ECTS 2,5 ECTS
3	Lehrende	Prof. Dr.-Ing. Andreas Maier Prof. Dr. Armin Michael Nagel Prof. Dr. Frederik Bernd Laun	

4	**Modulverantwortliche/r**	Prof. Dr. Frederik Bernd Laun
5	**Inhalt**	In this module,the physical and technical basics of MRI are taught in detail. The principles of data acquisition are explained and various examples are shown. Imperfections in the data acquisition lead to image artifacts that cannot be avoided in all cases. Strategies for detecting and avoiding image artifacts are explained. One of the great strengths of MRI in medical diagnostics is the ability to acquire images with different contrasts. The origin of the frequently used T1 and T2 weighted image contrasts is discussed in detail. Various MRI sequence techniques are also discussed."
6	**Lernziele und Kompetenzen**	The participants • understand the principles, properties and limits of basic MRI techniques • develop the ability to choose an appropriate basic MRI sequence and to set up the corresponding sequence parameters for a range of basic applications • are able to explain MRI techniques, algorithms and concepts of the lecture to other engineers.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (120 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 568977	**Magnetic Resonance Imaging 2 + Übung** Magnetic resonance imaging 2 + exercise	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr. Frederik Bernd Laun
5	**Inhalt**	In der Vorlesung werden fortgeschrittene Techniken der Magnetresonanztomographie (MRT) erklärt. Vorausgesetzt werden Kenntnisse über Grundlagen des Gebietes, wie sie z.B. in der Vorlesung Magnetic resonance imaging 1" behandelt werden (Blochgleichungen, T1- und T2-Wichtung, Schichtselektion, k-Raum-Kodierung). U.a. folgende Themen werden behandelt: Echoplanare Bildgebung; Bildgebung des Flusses, der Perfusion, der Diffusion, der magnetischen Suszeptibilität; funktionelle MRT; Ultrahochfeld-MRT; CEST-Bildgebung; MRT-Technik; Beschleunigungsverfahren, z.B. parallele Bildgebung; Angiographie; Bewegungskompensation. The lecture covers advanced topics in magnetic resonance imaging (MRI). Knowledge about the basic principles of MRI are required as they are covered in the lecture Magnetic Resonance Imaging 1" (Bloch equations, T1 and T2 weighting, slice selection, k-space encoding). I.a. the following topics will be treated: echo planar imaging; imaging of flow, perfusion, diffusion, magnetic susceptibility; functional MRI; ultrahigh field MRI; chemical exchange saturation transfer imaging; MRI technique; acceleration methods, e.g. parallel imaging; angiography; motion compensation.
6	**Lernziele und Kompetenzen**	The participants • understand the principles, properties and limits of advanced MRI techniques • develop the ability to adapt basic principles of MRI to advanced MRI techniques • are able to explain MRI techniques, algorithms and concepts of the lecture to other engineers.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (120 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	nur im Sommersemester

13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 47663	**Magnetic Resonance Imaging sequence programming [MRIpulseq]** Magnetic resonance imaging sequence programming [MRIpulseq]	**5 ECTS**
2	Lehrveranstaltungen	Seminar: Magnetic Resonance Imaging sequence programming [MRIpulseq] (0 SWS)	5 ECTS
3	Lehrende		

4	**Modulverantwortliche/r**	Prof. Dr. Moritz Zaiß
5	**Inhalt**	In this module in a two-week block course format, the basics of MR sequence programming are taught. Basic sequences such as FID, spin echo, and gradient echo are programmed in Python by the students themselves in this exercise. In addition, the basic image reconstruction based on the simulated and recorded data is written and carried out in Python, including radial imaging and iterative reconstruction. The sequences are created in a format that can be interpreted directly by MR scanners (https://pulseq.github.io). Part of the exercise will therefore be to use the created sequences on a real MRT machine in the Center for Medical Physics and Technology Generate signals from objects and test persons and reconstruct them into MRI images. Basic knowledge of Python is helpful, but can also be acquired in the exercise. The prerequisite for the exercise is knowledge of the Magnetic Resonance Imaging 1 [MRI1] lecture by Prof. Dr. Laun. For participation in the module, including an exercise with written report and demonstration in the following week, a total of 5 ECTS points with grade are given.
6	**Lernziele und Kompetenzen**	Students can create sequences in a format that can be interpreted directly by MR scanners (https://pulseq.github.io). In the exercise, they will use the created sequences on a real MRT machine in the Center for Medical Physics and Technology, generate signals from objects and test persons and reconstruct them into MRI images.
7	**Voraussetzungen für die Teilnahme**	Voraussetzung für die Übung sind Kenntnisse entsprechend der Vorlesung Magnetic Resonance Imaging 1 [MRI1] von Prof. Dr. Laun. Auskunft: moritz.zaiss@uk-erlangen.de
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel Portfolio exam: programming exercise (individual sequence task for each student) with written report (source code) and demonstration (15 min + questions) in the following week
11	**Berechnung der Modulnote**	Variabel (100%)

		Berechnung der Modulnote: programming exercise (90 %), demonstration (10 %)
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	https://www.studon.fau.de/studon/goto.php?target=crs_2819947 https://pulseq.github.io

1	**Modulbezeichnung** 57134	**People Analytics – Data Science für Human Resources Management** People analytics – Data science for human resources management	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung: People Analytics (4 SWS) People Analytics is organized as a self-study course. People Analytics ist als Selbstlernkurs organisiert.	5 ECTS
3	Lehrende	Prof. Dr. Sven Laumer	

4	**Modulverantwortliche/r**	Prof. Dr. Sven Laumer
5	**Inhalt**	Decision-making is a critical task for HR departments. They not only must handle the onboarding and offboarding of an employee, but are also responsible for optimizing each stage of the employee life cycle and all the processes related to it. Hence, HR experts seek the help of precise data to determine the best course of action. In small companies, information can be easily collected and organized; however, as companies grow, and their number of employee increases, the challenges of managing a larger workforce begins to surface. Thankfully, technological advancements have brought a new set of tools that HR experts can use to aid their decision making. With the right implementation, companies can measure the effectiveness of their business strategies, optimize resources, and improve the employee experience. In this context, People Analytics is a new concept that has been established in science and in practice, which comprises of the processes of collecting, analyzing, and reporting relevant HR information to make data-driven decisions. The lecture videos are pre-recorded and available via StudOn, but make sure to register via https://kurse.vhb.org/ first. Die Entscheidungsfindung ist eine wichtige Aufgabe für Personalabteilungen. Sie müssen sich nicht nur um das Onboarding und Offboarding eines Mitarbeiters kümmern, sondern sind auch für die Optimierung jeder Phase des Mitarbeiterlebenszyklus und aller damit verbundenen Prozesse verantwortlich. Daher sind die Personalverantwortlichen auf präzise Daten angewiesen, um die beste Vorgehensweise zu bestimmen. In kleinen Unternehmen können Informationen leicht gesammelt und organisiert werden. Wenn das Unternehmen jedoch wächst und die Zahl der Mitarbeiter zunimmt, werden die Herausforderungen der Verwaltung einer größeren Belegschaft immer größer. Glücklicherweise hat der technologische Fortschritt eine Reihe neuer Instrumente hervorgebracht, die HR-Experten bei der Entscheidungsfindung helfen können. Mit der richtigen Implementierung können Unternehmen die Effektivität ihrer Geschäftsstrategien messen, Ressourcen optimieren und die Erfahrungen ihrer Mitarbeiter verbessern. In diesem Zusammenhang ist People Analytics ein neues Konzept, das sich in der Wissenschaft und in der Praxis etabliert hat. Es umfasst die Prozesse der Sammlung,

		Analyse und Berichterstattung relevanter HR-Informationen, um datengestützte Entscheidungen zu treffen. Die Vorlesungsvideos sind voraufgezeichnet und über StudOn verfügbar. Bitte melden Sie sich vorher über die https://kurse.vhb.org/ an.
6	**Lernziele und Kompetenzen**	Students should be able to discuss why People Analytics is an important concept in the context of Human Resource Management, and differentiate between the different pillars of PA. Furthermore, they should be able to independently implement a People Analytics projects. Die Studierenden sollen erörtern können, warum People Analytics ein wichtiges Konzept im Kontext des Human Resource Managements ist, und die verschiedenen Säulen von PA unterscheiden können. Darüber hinaus sollen sie in der Lage sein, selbstständig ein People Analytics Projekt durchzuführen.
7	**Voraussetzungen für die Teilnahme**	• Students should have a basic familiarity with data mining and data analytics methods and tools. • Some elementary knowledge of programming in Python and R is recommended. • Die Studierenden sollten mit den Methoden und Werkzeugen des Data Mining und der Datenanalyse grundlegend vertraut sein. • Grundlegende Kenntnisse der Programmierung in Python und R werden empfohlen.
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (90 Minuten) The course evaluation will be conducted through a written examination on paper, lasting 90 minutes with a maximum of 90 points achievable. The exam will include a mix of single-choice questions, multiple-choice questions, and open-ended questions, covering all eight chapters of the course. Open-ended questions will account for 35% of the total score and will be based on short case studies, where students will be expected to discuss aspects of ML models and data analysis. The case studies introduced during lectures will serve as valuable guidance for preparing for this part of the exam. Die Leistungsbewertung des Kurses erfolgt durch eine schriftliche Prüfung auf Papier, die 90 Minuten dauert und bei der maximal 90 Punkte erreicht werden können. Die Prüfung besteht aus einer Kombination von Single-Choice-Fragen, Multiple-Choice-Fragen sowie offenen Fragen und deckt alle acht Kapitel des Kurses ab. Die offenen Fragen machen 35 % der Gesamtbewertung aus und basieren auf kurzen Fallstudien, in denen von den Studierenden erwartet wird, dass sie Aspekte von ML-Modellen und der Datenanalyse diskutieren. Die in den Vorlesungen behandelten Fallstudien dienen dabei als wertvolle Orientierung für die Vorbereitung auf diesen Teil der Prüfung.

11	**Berechnung der Modulnote**	Klausur (100%) The final grade will be determined solely on the basis of the written examination. Die Endnote wird ausschließlich auf Grundlage der schriftlichen Prüfung ermittelt.
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 0 h Eigenstudium: 150 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Deutsch Deutsch oder Englisch Englisch
16	**Literaturhinweise**	All relevant material will be provided in StudOn. Alle relevanten Materialien werden in StudOn zur Verfügung gestellt.

1	**Modulbezeichnung** 62766	**Physics I**	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung: Physics I (Clean Energy Processes) (3 SWS) Übung: Physics I (Clean Energy Processes, Exercise Class) (2 SWS)	- -
3	Lehrende	Dr. Angela Montanaro Prof. Dr. Daniele Fausti	

4	**Modulverantwortliche/r**	Prof. Dr. Christopher van Eldik
5	**Inhalt**	**Mechanics:** • Measurements, units, dimensions, magnitudes • Motion in one spatial dimension • Motion in three spatial dimensions • Newton's laws and concept of forces • Work, energy, power • Centre of gravity, momentum, impact processes • Rotational motion • Law of gravity • Mechanics of deformable bodies, liquids, gases **Oscillations and waves:** • Undamped, damped and forced oscillations • Superposition • Wave propagation • Diffraction • Geometrical optics **Thermodynamics:** • Temperature, ideal gas • Kinetic theory of gases • Real gas, phase diagram • Heat capacity, melting, evaporation energy • Thermal conductivity, thermal radiation • Heat engines, conversion efficiency
6	**Lernziele und Kompetenzen**	The students • can explain basics of mechanics and thermodynamics • have a basic understanding of how natural processes can be traced back to fundamental natural laws • apply the acquired knowledge to special situations and questions in mechanics and thermodynamics • have basic competence in analytical thinking as a means of describing scientific relationships accurately
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242

10	**Studien- und Prüfungsleistungen**	Klausur (90 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 150 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Halliday & Resnick's Principles of Physics (Wiley)

1	**Modulbezeichnung** 62768	**Physics II**	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr. Christopher van Eldik
5	**Inhalt**	**Electrodynamics:** • Electrostatics • Electrical current, voltage, resistance • Magnetostatics • Electrodynamics **Modern Physics:** • Quantum properties of light • Quantum mechanics • Atomic physics • Solid state physics • Nuclear and particle physics
6	**Lernziele und Kompetenzen**	The students • can explain basics of electrodynamics and modern physics • have a basic understanding of how natural processes can be traced back to fundamental natural laws • apply the acquired knowledge to special situations and questions in electrodynamics and modern physics • have basic competence in analytical thinking as a means of describing scientific relationships accurately
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (90 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 150 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Halliday & Resnick's Principles of Physics (Wiley)

1	**Modulbezeichnung** 92772	**Renewable energies**	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung: Renewable Energies (2 SWS) Übung: Renewable Energies (tutorial) (2 SWS)	- -
3	Lehrende	Arkya Sanyal Prof. Dr.-Ing. Jürgen Karl	

4	**Modulverantwortliche/r**	Prof. Dr.-Ing. Jürgen Karl
5	**Inhalt**	• Climate change and energy transition • Renewable electricity generation and transmission • Wind energy • Photovoltaics • Bioenergy • Geothermal energy • Hydropower • Heat and electricity storage • Sector coupling and system integration
6	**Lernziele und Kompetenzen**	Students who participate in this course will become familiar with basic concepts of conventional energies. Students who successfully participate in this module will • know the fundamentals of renewable energy conversion processes • assess environmental and social aspects of renewable energy conversion.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (90 Minuten)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	• Slides published via StudOn • Karl; Dezentrale Energiesysteme; Oldenbourg-Verlag

		• Sterner, Stadler; Energiespeicher - Bedarf, Technologien, Integration; Springer Verlag • Quaschning; Regenerative Energiesysteme: Technologie - Berechnung Simulation; Carl Hanser Verlag

1	**Modulbezeichnung** 92411	**Introduction to Molecular Biology**	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	PD Dr. Katja Kobow
5	**Inhalt**	The lecture provides a comprehensive introduction to the field of molecular biology covering basic terminology and concepts, cellular biology, basic and more advanced molecular genetics techniques, and bioinformatics. The final lecture also addresses important ethical considerations related to molecular biology research. **Potential Lectures:** • 1. Introduction to Molecular Biology (Definition of molecular biology, Historical development of molecular biology, Importance of molecular biology in modern science) • 2. Cell structure and function (Overview of cell structure, Types of cells, Cellular functions) • 3. DNA Structure and Function (Chemical structure of DNA, DNA replication, DNA repair) • 4. RNA Structure and Function (Chemical structure of RNA, Types of RNA, RNA transcription, Rybozymes) • 5. Genetic Code and Translation (Overview of genetic code, Protein synthesis, Regulation of translation) • 6. Gene Expression Regulation (Transcriptional regulation Post-transcriptional regulation, Epigenetic regulation) • 7. Mutations and Genetic Disorders (Types of mutations, Consequences of mutations, Genetic disorders and their causes) • 8. Recombinant DNA Technology (Techniques for DNA manipulation, Gene cloning and expression, Applications of recombinant DNA technology) • 9. Molecular Genetics Techniques I (Polymerase chain reaction (PCR), Sequencing, Southern/Northern/Western blotting) • 10. Molecular Genetics Techniques II (Microarrays, CRISPR/Cas9 genome editing, RNA interference (RNAi)) • 11. Genomics and Bioinformatics I (Genome sequencing, Genome annotation, Comparative genomics) • 12. Genomics and Bioinformatics II (Transcriptomics, Proteomics, Metagenomics) • 13. Molecular Biology Applications (Medical applications of molecular biology, Future of molecular biology research) • 14. Ethics and Social Implications of Molecular Biology (Ethical considerations in genetic research, Genetic testing

		and counseling, Public perception and policy surrounding molecular biology) • 15. Exam
6	**Lernziele und Kompetenzen**	Intended learning objectives (ILO): **Module-specific skills** On completing the module, students will be able to... • 1. Define molecular biology and its relevance in modern science. • 2. Understand the basic concepts of molecular biology, including DNA, RNA, and proteins • 3. Outline cellular structures and functions • 4. Explain how DNA replication, transcription, and translation occur • 5. Understand basic concepts of gene regulation mediated by, e.g., transcription factors and epigenetic mechanisms • 6. Understand basic genetic concepts and the role of genetic variation and mutations in health and disease • 7. Identify and explain molecular genetic methods that are appropriate to study DNA, RNA, and proteins with targeted or high-throughput approaches • 8. Discuss ethical and social implications as well as applications of molecular biology ILO: **Discipline-specific skills** On completing the module, students will be able to... • 9. Describe some research methods and and key concepts of molecular biology. ILO: **Personal and key skills** On completing the module, students will be able to... • 10. Communicate scientific concepts effectively using oral, written, and other media. • 11. With some guidance, select and interpret information drawn from books, scientific journals, databases, and websites and begin to develop the skill of critical appraisal. • 12. Interact effectively in a group. • 13. Develop the necessary skills for self-directed learning.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (60 Minuten) Written examination 120 min (MC). May also be organized as two written examinations 60 min each.
11	**Berechnung der Modulnote**	Klausur (100%) Written examination (100%).
12	**Turnus des Angebots**	nur im Sommersemester

13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 92412	**Neuroanatomy and Neurophysiology**	**5 ECTS**
2	Lehrveranstaltungen	Zu diesem Modul sind keine Lehrveranstaltungen oder Lehrveranstaltungsgruppen hinterlegt!	
3	Lehrende	Zu diesem Modul sind keine Lehrveranstaltungen und somit auch keine Lehrenden hinterlegt!	

4	**Modulverantwortliche/r**	PD Dr. Katja Kobow
5	**Inhalt**	The lecture provides a basic introduction into the systematic and functional micro- and macroscopic anatomy of the central nervous system. Basics of neuroradiology and neurophysiology as well as human pathoneurophysiology. Introduction to neurological diseases. Methodology and data sources to study brain function. Discussion of potential AI applications in biomedicine with focus on the CNS. The interactive seminar in pathoneurophysiology concentrates on gross anatomy and histology of the human brain and spinal cord in common CNS diseases and providing some hands on experience and further recapitulating and applying theoretical concepts from the lecture to the real world. **Potential Lectures:** • 1. Introduction to the Central Nervous System (gross structure and organization, development and evolution, research methods – imaging, MRI & PET) • 2. Introduction to Neurophysiology 1 (Neurons, Interneurons, Astrocytes, Microglia, Oligodendroglia and other cell types in the brain, research methods – microscopy and molecular biology) • 3. Introduction to Neurophysiology 2 (Basic Neurochemistry, Action potential, Neurotransmitters, research methods – EEG and electrophysiology) • 4./5. The Cortex (macroscopy, histology, function: motor, language, sensory, hippocampus and limbic system: learning and memory, basal ganglia and thalamus: motor control, behaviour, and emotions, disorders – Epilepsy, Tumors, Neurodegeneration) • 6. Blood and CSF (blood supply and meninges, BBB, CSF flow, disorders – Infarction, Intracerebral Haemorrhage) • 7. The Cerebellum (regional organization, functional division, disorders – Spinocerebellar Ataxia) • 8. The Brainstem and Spinal cord (important nuclei, motor neurons, disorders – PD, ALS) • 9. Neuroendocrine system (hormones, circadian rhythm) • 10. Vestibular, Visual and Olfactory Systems (structure, function, disorders) • 11. Pain (acute and chronic) • 12.-14. Research Highlights • 15. Exam

6	**Lernziele und Kompetenzen**	Intended learning objectives (ILO): **Module-specific skills** On successfully completing the module students will be able to... • 1. Describe the development, major subdivisions, meninges, CSF and blood supply of the CNS. • 2. Identify different cell types of the brain and describe their basic function • 3. Describe the segmental anatomy and functional divisions of the spinal cord and specify a disease associated with pathology in this region. • 4. Outline the major divisions of the brainstem and cerebellum, identify the origins and targets of important neurotransmitters, and specify at least one disease of both structures. • 5. Explain the importance of the basal ganglia and thalamus in regulating motor behaviours. Describe the major nuclei and their connections of the limbic system and these influence emotion. • 7. Characterize the spatial organization of the cerebral cortex and its connections to subcortical and other structures. Describe at least one disease associated with neurodegeneration of the cerebral cortex. • 8. Identify methods which are appropriate to study different levels of organization and functions of the CNS: cellular, regional, global. ILO: **Discipline-specific skills** On successfully completing the module you will be able to... • 10. Describe some laboratory and imaging methods that are used to study different levels of organization of the brain. ILO: **Personal and key skills** On successfully completing the module you will be able to... • 11. Communicate scientific concepts effectively using oral, written, and other media. • 12. With some guidance, select and interpret information drawn from books, scientific journals, databases, and websites and begin to develop the skill of critical appraisal. • 13. Interact effectively in a group. • 14. Develop the necessary skills for self-directed learning.
7	**Voraussetzungen für die Teilnahme**	Recommended: • Introduction to Molecular Biology
8	**Einpassung in Studienverlaufsplan**	Semester: 1
9	**Verwendbarkeit des Moduls**	Application Domain Fundamentals Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur (60 Minuten) Written examination 120 min. May also be organized as two written examinations 60 min each.
11	**Berechnung der Modulnote**	Klausur (100%) Written examination (100%).

12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

Artificial Intelligence Electives

Students must obtain a total of 30 ECTS in the area of "AI Electives".

1	**Modulbezeichnung** 93101	**AI in medical robotics**	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung mit Übung: AI in Medical Robotics (4 SWS)	5 ECTS
3	Lehrende	Prof. Dr. Franziska Mathis-Ullrich Dr.-Ing. Christian-Peter Kunz	

4	**Modulverantwortliche/r**	Prof. Dr. Franziska Mathis-Ullrich
5	**Inhalt**	This module is concerned with artificial intelligence technologies in medical robotics and with methods that establish different forms of intelligence in medical robotic systems. Participants will become familiar with the design and application of AI methods and algorithms for perception, motor control, planning, cognition and learning and with their application in biorobotic systems and robotic solutions for diagnosis and treatment. Application domains include minimally invasive surgery, motor rehabilitation, exoskeletons and assistive devices, as well as medical service robotics. The taught methods will be applied to application data during designated computer exercises that are integrated into the course. Topics include, but are not limited to: • Basic principles and classification of artificial intelligence • Overview of AI methods and technologies in medical imaging • Implications of surgical workflow planning using AI methods • Motion planning in robotic surgery, rehabilitation robots and medical service robots • Perception in robotic surgery, rehabilitation robots and assistive robots • Motion planning in robotic surgery, rehabilitation robots and assistive robots • Adaptation and Learning in Human-Robot Interaction • Design criteria and regulations for AI-based medical systems
6	**Lernziele und Kompetenzen**	• Students are able to employ artificial intelligence technologies and methods for applications in medical robotics. • They are capable of understanding and handling the complexity of biorobotic AI systems and have command of a versatile set of methods for analyzing and further advancing such systems. • They are able to combine different tools and methods to achieve intelligent perception, planning, control, learning and cognition in robotic solutions for minimally invasive surgery, motor rehabilitation robotics, and medical service robotics.
7	**Voraussetzungen für die Teilnahme**	Participants should be familiar with fundamentals of linear algebra. It is advantageous but not required to be have some prior knowledge on robotics, basic methodologies of AI, and basic probability theory.
8	**Einpassung in Studienverlaufsplan**	Semester: 5

9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur Written examination (60 min)
11	**Berechnung der Modulnote**	Klausur (100%) Written examination (100 %)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 47678	**Algorithmische Bioinformatik** Algorithmic Bioinformatics	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung mit Übung: Algorithmic Bioinformatics (4 SWS)	5 ECTS
3	Lehrende	Dr. Anne Hartebrodt Prof. Dr. David Blumenthal	

4	**Modulverantwortliche/r**	Prof. Dr. David Blumenthal
5	**Inhalt**	With the growing amount of readily available molecular profiling data, algorithms for analyzing these data are getting more and more important. This lecture provides a close-up view on a selection of these algorithms and introduces the biomedical problems which are addressed by them. In particular, the lecture will cover the following topics: • A very brief introduction to molecular biology. • Algorithms for global and local sequence alignment. • Algorithms for de novo sequence assembly. • Algorithms for secondary RNA structure prediction. • Algorithms for exploratory omics data analysis. • Algorithms for network alignment. • Algorithms for disease mechanism mining in biological networks.
6	**Lernziele und Kompetenzen**	Students will • be able to explain the basics of molecular biology, • be able to explain fundamental algorithms used in the field, • be able to use paradigms of algorithm design such as dynamic programming, local search, and ant colony optimization in concrete application scenarios, • be able to reimplement the covered algorithms, • be able to provide detailed, technical explanations of the covered algorithms.
7	**Voraussetzungen für die Teilnahme**	Since the lecture will be accompanied by programming exercises in Python, prior knowledge of this programming language is recommended. For students without prior experience, a very brief introduction to Python will be provided in the first two exercise sessions.
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel Oral exam 30 min.
11	**Berechnung der Modulnote**	Variabel (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h

14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Pointers to relevant papers will be provided throughout the lecture and be made available on StudOn. As optional accompanying literature, the following textbooks are recommended: • Phillip Compeau & Pavel Pevzner: Bioinformatics Algorithms: An Active Learning Approach, Active Learning Publishers, 2018. • Patrick Siarry (Ed.): Metaheuristics, Springer International Publishing, 2016.

1	**Modulbezeichnung** 47544	**Applied Data Science in Medicine & Psychology** Applied data science in medicine & psychology	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Luca Abel Prof. Dr. Björn Eskofier Veronika Ringgold Prof. Dr. Nicolas Rohleder
5	**Inhalt**	The interdisciplinary module „Applied Data Science in Medicine & Psychology“ covers basic statistical knowledge and hands-on Python exercises. We will start with relevant knowledge from both disciplines (statistics and programming), which will allow you to analyze your data more efficiently. Since this is a course for students from many different disciplines (life sciences, psychology, medical engineering, etc.) we will gradually build up your knowledge which will allow you to cover more complex ideas as we move through the course. Our goal is to provide you with the necessary knowledge, skills, and tools for future projects, such as theses, and to prepare those of you who wish to pursue a career in science. This course will also complement the seminars „Digital Health Psychology“ and „Digitalization in Clinical Psychology“, as prior knowledge of Python and data analysis will enhance the benefit of both seminars for you.
6	**Lernziele und Kompetenzen**	Students: • Develop a programming mindset • Gain an understanding of research data management • Acquire basic python coding skills • Gain a basic understanding of inference statistic • Can load, manipulate, analyze, and visualize data • Understand basics of machine learning
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel Written e-Exam (60 min)
11	**Berechnung der Modulnote**	Variabel (100%) Exam (100%)
12	**Turnus des Angebots**	nur im Sommersemester

13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 47587	**Best Practices in Open Science** Best practices in open science	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung mit Übung: Best Practices in Open Science (4 SWS)	5 ECTS
3	Lehrende		

4	**Modulverantwortliche/r**	Luca Abel Prof. Dr. Björn Eskofier Veronika Ringgold Prof. Dr. Nicolas Rohleder
5	**Inhalt**	The interdisciplinary lecture and exercise „Best Practices in Open Science“ covers the topics that researchers and (young) scientists should know about the Open Science movement. We will start by explaining the importance of open and reproducible science and how researchers, institutions and the general public benefit from it. We will discuss the Pros and Cons as well as best and worst practices and case studies. After completing this course, students will have gained an overview over the steps to take for more accountability in their own research. Our goal is to provide you with the necessary knowledge, skills, and tools for future projects, such as theses, and to prepare those of you who wish to pursue a career in science.
6	**Lernziele und Kompetenzen**	Students: • Gain an understanding of the importance of Open Science • Understand concepts such as open data, open access and reproducibility • Will know about best (and worst) practices • Acquire the relevant knowledge to make their own research more open • Can plan and pre-register a study as well as share (reproducible) code
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel Written Exam, English, (60 min)
11	**Berechnung der Modulnote**	Variabel (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 30 h Eigenstudium: 120 h

14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 93109	**Computational Magnetic Resonance Imaging** Computational magnetic resonance imaging	**5 ECTS**
2	Lehrveranstaltungen	Vorlesung: Computational Magnetic Resonance Imaging Vorlesung (2 SWS) Übung: Computational Magnetic Resonance Imaging Uebung (2 SWS)	2,5 ECTS 2,5 ECTS
3	Lehrende	Jinho Kim Prof. Dr. Florian Knoll	

4	**Modulverantwortliche/r**	Prof. Dr. Florian Knoll
5	**Inhalt**	Computational Magnetic Resonance Imaging provides a deeper look into computational and machine learning methods for the inverse problem of MRI data acquisition and image reconstruction. It is organized as a series of lectures with accompanying programming exercises. In the exercises, students will use Matlab or Python and PyTorch to implement and test the different methods discussed in class. Topics covered will include but are not limited to: • Recap of MR signal and encoding, Fourier imaging • Introduction to the inverse problem of imaging • Partial Fourier imaging • Parallel imaging • Compressed sensing • Machine Learning in MRI
6	**Lernziele und Kompetenzen**	After completing this course, students will be able to: • Understand the theory and algorithms of MR data acquisition and image reconstruction • Apply them themselves in real-world MR imaging tasks
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Übungsleistung Variabel Participants have to solve weekly graded exercises. The final exam is a 60-minutes written exam.
11	**Berechnung der Modulnote**	Übungsleistung (bestanden/nicht bestanden) Variabel (100%) The grade is determined by the final exam. The grade can be improved by up to 0.7 with bonus points that are awarded for successful completion of the exercises.
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h

14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Z.P. Liang. Constrained Reconstruction Methods in MR Imaging. http://mri.beckman.illinois.edu/resources/liang_1992_constrained_imaging_review.pdf D. Nishimura. Principles of Magnetic Resonance Imaging. https://www.lulu.com/en/us/shop/dwight-nishimura/principles-of-magnetic-resonance-imaging/paperback/product-1nqdq4j2.html?page=1&pageSize=4 M. Bernstein. Handbook of MRI Pulse Sequences. https://www.amazon.com/Handbook-Pulse-Sequences-Matt-Bernstein/dp/0120928612

1	**Modulbezeichnung** 44200	**Computational Neurotechnology / Numerische Neurotechnologie** Computational neurotechnology / Numerical neurotechnology	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr. Tobias Reichenbach
5	**Inhalt**	Foundations of Computational Neuroscience and the processing of neural signals. Applications in the areas of artificial neural networks, Brain-Machine-Interfaces (BCIs) and neural prosthesis.
6	**Lernziele und Kompetenzen**	• Can understand the principles of the analysis of neural signals • Can apply information theory for the description of neural activity • Can perform simulations of the dynamics of single neurons as well as of neural networks • Can evaluate different approaches to construct Brain-Machine-Interfaces (BCIs) • Can explain concepts for the design of neural prosthesis
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Klausur Written exam (60 minutes)
11	**Berechnung der Modulnote**	Klausur (100%)
12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Dayan, Peter, and Laurence F. Abbott. Theoretical neuroscience: computational and mathematical modeling of neural systems. Computational Neuroscience Series, 2001. Gerstner, Wulfram, et al. Neuronal dynamics: From single neurons to networks and models of cognition. Cambridge University Press, 2014.

		Oweiss, Karim G., ed. Statistical signal processing for neuroscience and neurotechnology. Academic Press, 2010. Maurits, Natasha. From neurology to methodology and back: an introduction to clinical neuroengineering. Springer Science & Business Media, 2011. Clément, Claude. Brain-Computer Interface Technologies. Springer International Publishing, 2019. DiLorenzo, Daniel J., and Joseph D. Bronzino, eds. Neuroengineering. CRC Press, 2007.

1	**Modulbezeichnung** 645618	**Human Computer Interaction** Human computer interaction	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr. Björn Eskofier Madeleine Flaucher
5	**Inhalt**	Das Modul vermittelt Konzepte, Prinzipien, Modelle, Methoden und Techniken für die effektive Entwicklung von benutzerfreundlichen Mensch-Computer-Schnittstellen. Das Thema moderner Benutzungsschnittstellen wird dabei für klassische Computer aber auch für mobile Geräte, eingebettete Systeme, Automobile und intelligente Umgebungen betrachtet. Die folgenden Themen werden im Modul behandelt: • Einführung in die Grundlagen der Mensch-Computer-Interaktion, historische Entwicklung • Entwurfsprinzipien und Modelle für moderne Benutzungsschnittstellen und interaktive Systeme • Informationsverarbeitung des Menschen, Wahrnehmung, Motorik, Eigenschaften und Fähigkeiten des Benutzers • Interaktionskonzepte und -stile, Metaphern, Normen, Regeln und Style Guides • Ein- und Ausgabegeräte, Entwurfsraum für interaktive Systeme • Analyse-, Entwurfs- und Entwicklungsmethoden und -werkzeuge für Benutzungsschnittstellen • Prototypische Realisierung und Implementierung von interaktiven Systemen, Werkzeuge • Architekturen für interaktive Systeme, User Interface Toolkits und Komponenten • Akzeptanz, Evaluationsmethoden und Qualitätssicherung Contents: The module aims to teach basic knowledge of concepts, principles, models, methods and techniques for developing highly user-friendly Human-Computer Interfaces. Beyond traditional computer systems, modern user interfaces are also discussed in the context of automobile and intelligent environments, mobile devices and embedded systems. This module addresses the following topics: • Introduction to the basics of Human-Computer Interaction • Design principles and models for modern user interfaces and interactive systems • Information processing of humans, perception, motor skills, properties and skills of the users

		• Interaction concepts, metaphors, standards, norms and style guides • In- and output devices, design space for interactive systems • Analysis-, design- and development of methodologies and tools for easy-to-use user interfaces • Prototypic implementation of interactive systems • Architectures for interactive systems, User Interface Toolkits and components • Acceptance, evaluation methods and quality assurance
6	**Lernziele und Kompetenzen**	• Studierende entwickeln ein Verständnis für Modelle, Methoden und Konzepte der Mensch-Computer-Interaktion. • Sie lernen verschiedene Ansätze für den Entwurf, die Entwicklung und Bewertung von Benutzungsschnittstellen kennen und verstehen deren Vor- und Nachteile. • Die Teilnahme an der Veranstaltung versetzt Studierende in die Lage, einen Entwicklungsprozess in der Mensch-Computer-Interaktion zu verstehen und umzusetzen. • Sie werden weiterhin in die Lage versetzt, dies vor dem Hintergrund der Informationsverarbeitungsfähigkeit, Wahrnehmung und Motorik des Benutzers zu gestalten. • Passende Methoden der Evaluation sowie Akzeptanz- und Qualitätssicherung werden erlernt. Learning Objectives and Competences: • Students develop an understanding of models, methods and concepts in the field of Human-Computer Interaction. • They learn different approaches for designing, developing and evaluating User Interfaces and their advantages and disadvantages. • Joining the course enables students to understand and execute a development process in Human-Computer Interaction. • Students will be able to do a UI evaluation by learning the basics of information processing, perception and motoric skills of the user. • Appropriate evaluation methods, as well as acceptance and quality assurance aspects, will be learned.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	elektronische Prüfung Electronic exam (in presence), 90min
11	**Berechnung der Modulnote**	elektronische Prüfung (100%)
12	**Turnus des Angebots**	nur im Sommersemester

13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 47616	**Intent Detection and Feedback** Intent detection and feedback	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr. Claudio Castellini
5	**Inhalt**	• Introduction to the problems of intent detection and somatosensory feedback: motivation, taxonomy, historical background. • Intent detection: theory and philosophical issues; defining the problem and the ground truth; success metrics; signals for intent detection; sensors for intent detection; feature extraction; applications of machine learning to the problem. • Somatosensory feedback: theory and physiology; sensory substitution; embodiment and agency induced by it; modalities of actuation; practical issues and metrics of performance. • Intent detection and somatosensory feedback in prosthetics: usefulness, success and challenges. • Intent detection and somatosensory feedback in rehabilitation and exoskeletons: usefulness, success and challenges. • Intent detection and somatosensory feedback in gaming and non-reha fields.
6	**Lernziele und Kompetenzen**	Students who have followed the module • have a broad understanding of intent detection and somatosensory feedback, especially in the frame of Rehabilitation and Assistive Robotics • can conceive and design a research project in the related subfield of the subject • have knowledge about the clinical and industrial situation of intent detection and feedback, especially including the problems and challenges of each technique and method • can tackle previously unknown problems
7	**Voraussetzungen für die Teilnahme**	Recommended: basic maths, especially statistics; fundamentals of signal processing and machine learning; mid-level programming Python, C# or similar; fundamentals of experimental psychology
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel (60 Minuten) Written examination (60 min)
11	**Berechnung der Modulnote**	Variabel (100%) Written examination (100 %)

12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	• [2010] Control of Hand Prostheses Using Peripheral Information, S. Micera, J. Carpaneto and S. Raspopović. • [2012] Control of Upper Limb Prostheses: Terminology and Proportional Myoelectric ControlA Review, A. Fougner, Ø. Stavdahl, P. J. Kyberd, Y. G. Losier and P. A. Parker. • [2015] Michael R Tucker et al., Control strategies for active lower extremity prosthetics and orthotics: a review, JNER 12:1 • [2015] A survey of sensor fusion methods in wearable robotics, D. Novak and R. Riener • [2016] Incremental Learning of Muscle Synergies: From Calibration to Interaction, C. Castellini. • [2018] JA Spanias, AM Simon, SB Finucane, EJ Perreault and LJ Hargrove, Online adaptive neural control of a robotic lower limb prosthesis, J Neural Eng. 15(1) • [2020] Jacob Rosen and Peter Walker Ferguson (eds.), Wearable Robotics Systems and Applications, Academic Press Elsevier • [2021] Michele Xiloyannis, Ryan Alicea, Anna-Maria Georgarakis, Florian L. Haufe, Peter Wolf, Lorenzo Masia and Robert Riener, Soft robotic suits: State of the art, core technologies and open challenges, IEEE Transactions on Robotics

1	**Modulbezeichnung** 93340	**Introduction to Network Science** Introduction to network science	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr. David Blumenthal
5	**Inhalt**	Networks are fundamental data structures for modeling and analyzing complex biological, technological, or social systems. This course provides an introduction to the science of complex networks and their applications. The following topics will be covered: • Very brief introduction to graph theory, the mathematical underpinning of network science, • node centrality measures, • models of random networks, • network motifs, • degree correlations, • community detection, • network distance models, • evolving networks, • temporal networks.
6	**Lernziele und Kompetenzen**	Students will • get familiar with the basics of graph theory, • learn how to use networks to model complex relationships, • get familiar with the most important techniques for analyzing complex networks, • acquire hands-on experience in analyzing complex networks with the widely used Python library NetworkX.
7	**Voraussetzungen für die Teilnahme**	Since the lecture will be accompanied by programming exercises in Python, prior knowledge of this programming language is recommended. For students without prior experience, a very brief introduction to Python will be provided in the first two exercise sessions.
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel Oral exam 30 minutes.
11	**Berechnung der Modulnote**	Variabel (100%)
12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h

14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	A. Barabási and M. Pósfai, Network Science, Cambridge University Press, Cambridge, 2016, http://barabasi.com/networksciencebook/.

1	**Modulbezeichnung** 47582	**Systems Immunology and Infectiology** Systems immunology and infectiology	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Prof. Dr. Frederik Graw
5	**Inhalt**	The lecture will cover selected topics in systems immunology and infectiology, which aim at revealing the complex dynamical processes during infection, inflammation and cancer. We will learn different concepts of using mathematical models and computational methods to address fundamental questions of immune and infection dynamics. This includes among others the spread of pathogens within hosts, the dynamics of immune responses and the evolution of drug resistance. In the various lectures, we will investigate how different data analytical methods and concepts (e.g., from mathematical modelling, bioinformatics and ML) play a pivotal role in understanding infection and immunity. The lectures are accompanied by tutorials with practical exercises, including small programming exercises in R.
6	**Lernziele und Kompetenzen**	The participants will learn • to analyse immunological and virological data • to apply basic methods for analysing dynamic processes • to use basic concepts of mathematical modelling to study complex systems and dynamics
7	**Voraussetzungen für die Teilnahme**	The following prerequisites are strongly recommended • Basic knowledge of mathematics and dynamical systems (ordinary differential equations, statistics) • Basic knowledge of the programming language R • Interest in data analytical methods
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Electives Bachelor of Science Artificial Intelligence 20242 This course is appropriate for students within their last year of BSc in quantitative disciplines or MSc students interested in immunological data sciences (e.g. BSc/MSc Artificial Intelligence; BSc/MSc Data Science; MSc Medical Engineering; MSc Molecular Medicine; MSc Integrated Life Sciences; MSc Integrated Immunology).
10	**Studien- und Prüfungsleistungen**	Variabel Until WS 24/25 (inclusive): oral examination at end of semester. From SS 25: written examination (60 min.). Aditionally, weekly exercise sheets (1 DINA 4 page with 2-3 exercises per week).

11	**Berechnung der Modulnote**	Variabel (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	• Keeling MJ & Rohani P: Modeling Infectious Diseases in Humans and Animals, Princeton Univ. Press 2009 • Nowak MA & May RM: Virus dynamics, Oxford Univ. Press 2000 • Murray JD: Mathematical Biology II – Spatial models and Biomedical applications, Springer 2004

Artificial Intelligence Seminar

Students choose 1 module from the "AI Seminar" catalog.

1	**Modulbezeichnung** 47704	**Digitalization in Clinical Psychology**	**5 ECTS**
2	Lehrveranstaltungen	Im aktuellen Semester werden keine Lehrveranstaltungen zu dem Modul angeboten. Für weitere Auskünfte zum Lehrveranstaltungsangebot kontaktieren Sie bitte die Modul-Verantwortlichen.	
3	Lehrende	-	

4	**Modulverantwortliche/r**	Luca Abel Prof. Dr. Björn Eskofier
5	**Inhalt**	The interdisciplinary course „Digitalization in Clinical Psychology“ is designed for students of psychology, medical engineering and neighboring sciences. Current issues from the fields of digital health and psychotherapy research are addressed in groups. The goal of this research-oriented course is to strengthen the cooperation between the individual disciplines in order to make optimal use of mutual synergy effects. Students will use their individual skills learned during their studies in interdisciplinary teams to benefit from each other. In addition to the planning and execution of a research question as well as analysis of the results in groups, there will also be teaching units of the different disciplines during the semester, such as basic knowledge about psychological, psychosomatic and neuropsychological diseases and their psychotherapeutic treatment, hypothesis-driven planning and execution of experiments, inferential statistics, data analysis in Python, and acquisition and processing of physiological signals. In addition, fundamentals of scientific work and research data management are taught.
6	**Lernziele und Kompetenzen**	Students: • can explain current developments at the intersection of digital health and psychology • are able to independently research, evaluate and present a topic in the context of clinical psychology • can identify opportunities and challenges of machine learning and digital health in the field of psychology • are able to identify and understand relevant literature and present findings in a structured manner • can present implementation and validation results in the form of a presentation and a scientific paper.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Seminar Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Seminarleistung

		Seminar achievement (presentation, c.a. 30 min., and written report, 8 pages)
11	**Berechnung der Modulnote**	Seminarleistung (100%)
12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 30 h Eigenstudium: 45 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 47619	**Seminar Machine Learning in MRI** Seminar: Machine learning in MRI	**5 ECTS**
2	Lehrveranstaltungen	Hauptseminar: Machine Learning in MRI (4 SWS) Attendance is compulsory for the mid-term presentations.	5 ECTS
3	Lehrende	Erik Gösche Vanya Saksena	

4	**Modulverantwortliche/r**	Prof. Dr. Florian Knoll
5	**Inhalt**	We will cover recent machine learning developments in the areas of Magnetic Resonance (MR) data acquisition, image generation, image analysis and image interpretation. We will go over papers from leading international journals and conferences. Students can either suggest their own topics/papers or select from a range of papers presented by the lecturers. Each student will then study the assigned papers, discuss them with the lectures and at the end of the semester give a presentation about the key findings.
6	**Lernziele und Kompetenzen**	After completing this course, students will be able to: • critically read and understand a scientific paper in the fields of medical imaging and machine learning. • present a complex topic in their own words to their peers.
7	**Voraussetzungen für die Teilnahme**	None
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Seminar Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Seminarleistung Presentation (20 Minutes + 10 Minutes discussion) Written report (5-7 pages)
11	**Berechnung der Modulnote**	Seminarleistung (100%) Presentation and discussion 50%, Report 50%
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 150 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 47673	**Network medicine**	**5 ECTS**
2	Lehrveranstaltungen	Hauptseminar: Network Medicine (2 SWS)	5 ECTS
3	Lehrende	Prof. Dr. David Blumenthal	

4	**Modulverantwortliche/r**	Prof. Dr. David Blumenthal
5	**Inhalt**	Network medicine is an emerging research field which leverages techniques from molecular biology, bioinformatics, combinatorial optimization, and artificial intelligence to uncover potential disease mechanisms and candidates for causally effective treatments in heterogeneous molecular networks. In this seminar, students will dive into selected hot topics in network medicine.
6	**Lernziele und Kompetenzen**	Students will • be able to explain hot topics in the field of network medicine, • be able to identify, understand, and contextualize relevant research literature, • be able to give a presentation for a scientific audience, • be able to write an academic report.
7	**Voraussetzungen für die Teilnahme**	Some prior knowledge in graph theory and/or network science is recommended.
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Seminar Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Seminarleistung Written mini-survey (4 pages double column) + oral presentation of mini-survey (20 min + 10 min Q & A) + lead of discussion following oral presentation of another seminar participant (10 min).
11	**Berechnung der Modulnote**	Seminarleistung (100%) Written mini-survey (40%), oral presentation of mini-survey (40%), lead of discussion following oral presentation of another seminar participant (20%).
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 30 h Eigenstudium: 120 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	All relevant literature will be made available in StudOn. For background reading, students can consult the following textbook: • Loscalzo, Joseph, Albert-László Barabási, and Edwin K. Silverman (eds.): Network Medicine: Complex Systems in Human Disease and Therapeutics. Harvard University Press, 2017.

1	**Modulbezeichnung** 47581	**Seminar Quantifying lymphocyte dynamics** Seminar: Quantifying lymphocyte dynamics	**5 ECTS**
2	Lehrveranstaltungen	Seminar: Quantifying lymphocyte dynamics (2 SWS) Attendance is mandatory.	-
3	Lehrende	Prof. Dr. Frederik Graw	

4	**Modulverantwortliche/r**	Prof. Dr. Frederik Graw
5	**Inhalt**	Quantifying and understanding the dynamics of immune cells, i.e., lymphocytes, during health and disease is an important prerequisite for the design of appropriate treatment regimens and vaccination approaches. In this seminar, we will discuss the combination of different types of experimental data with various mathematical, computational and data analytical methods to quantify the generation, proliferation and differentiation dynamics of immune cells. We will see how the advancement of experimental methods, such as cellular barcoding or scRNA-seq, requires more sophisticated data analytical methods, including concepts from machine learning, and how this has advanced our understanding of lymphocyte dynamics.
6	**Lernziele und Kompetenzen**	The participants will present various concepts based on scientific papers, discussing the experimental approaches in combination with the mathematical methods. Participants will • learn to combine experimental data and data analytical methods to infer immunological processes • learn to carefully interpret various data types • learn the promises and limitations of different immunological data
7	**Voraussetzungen für die Teilnahme**	This interdisciplinary seminar is intended for students with a background in the life sciences and interest for data analytical methods and/or for students from quantitative subjects (AI, Data Science, Mathematics, (Bio-)Physics). Basic knowledge of mathematics (ordinary differential equations, statistics) and interest in interdisciplinary work is strongly recommended.
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Seminar Bachelor of Science Artificial Intelligence 20242 This course is appropriate for students within their last year of BSc in quantitative disciplines or MSc students interested in immunological data science (e.g. BSc/MSc Artificial Intelligence; BSc/MSc Data Science; MSc Medical Engineering; MSc Molecular Medicine; MSc Integrated Life Sciences; MSc Integrated Immunology).
10	**Studien- und Prüfungsleistungen**	Seminarleistung Successful participation of the course will be based on • Individual presentation (30 minutes) • Written assignment (10-15 pages) • Participation in the seminars and discussions

11	**Berechnung der Modulnote**	Seminarleistung (100%)
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 30 h Eigenstudium: 120 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	Exemplary articles: • De Boer et al.: Quantifying T lymphocyte turnover, J. Theo Biol. 2013 • Gossel et al.: Memory CD4 T cell subsets are kinetically heterogeneous and replenished from naive T cells at high levels, Elife 2017 • Gerlach et al.: Heterogeneous Differentiation Patterns of Individual CD8+ T Cells, Science 2013 • Pei et al.: Using Cre-recombinase-driven Polylox barcoding for in vivo fate mapping in mice. Nat. Protocols 2019 • Saelens et al.: A comparison of single-cell trajectory inference methods, Nat Biotechn. 2019

1	**Modulbezeichnung** 93113	**Seminar Humans in the Loop: The Design of Interactive AI Systems** Seminar: Humans in the loop: The design of interactive AI systems	**5 ECTS**
2	Lehrveranstaltungen	Hauptseminar: Seminar Humans in the Loop: The Design of Interactive AI Systems (2 SWS)	5 ECTS
3	Lehrende		

4	**Modulverantwortliche/r**	Prof. Dr. Bernhard Kainz
5	**Inhalt**	This is a joint seminar between Prof. Kainz (FAU Erlangen-Nuremberg) and Prof. Ledig (University of Bamberg). The seminar will take place at Bamberg Campus and FAU Campus. Initial topic selection and pitch presentation will take place in Bamberg. Final topic presentations will take place in Erlangen. Human-in-the-Loop Machine Learning describes processes in which humans and Machine Learning algorithms interact to solve one or more of the following: Making Machine Learning more accurate Getting Machine Learning to the desired accuracy faster Making humans more accurate Making humans more efficient Aim of this seminar is to give students insights about state-of-the-art Active Learning and interactive data analysis methods. Students will work independently on specific topics including implementation and analytical components alongside lectures delivered by the course lead, guest lectures and flipped classroom sessions, where students explore a topic independently, which is then discussed in class. Several potential topics will be provided but students are also encouraged to propose their own topics (after discussion with course lead). Topics covered will include but are not limited to: Introduction to Human-in-the-Loop Machine Learning • Active Learning Strategies: • Uncertainty Sampling • Diversity Sampling • Other Strategies Annotating Data for Machine Learning • Who are the right people to annotate your data? • Quality control for data annotation • User interfaces for data annotation Transfer Learning and Pre-Trained Models • What are Embeddings? • What is Transfer Learning? Adaptive Learning • Machine-Learning for aiding human annotation • Advanced Human-in-the-Loop Machine Learning

6	**Lernziele und Kompetenzen**	You will learn about the potential as well as current challenges when building and translating AI systems into real world applications. The focus of the seminar will be biased towards approaches based on computer vision algorithms and medical image processing. Specifically, you will learn about the state of the art in the context of selected applications. You will also get the opportunity to learn about negative examples of AI systems that failed to deliver on promises, regulatory constraints, patient privacy and data management. The seminar will allow you, based on your interest, to focus on a wide spectrum of aspects ranging from recently published technical solutions to the state of affairs on the policy level. Learning objectives are: • In-depth knowledge of human-in-the-loop machine learning, including deeper insight into current research. • A capability to work independently on application-driven projects. • To use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues. • To follow a scientific approach, formulating hypotheses, validation through experimentation and statistical analysis. • To plan and use adequate methods to conduct qualified tasks in given frameworks and to evaluate this work. • To create, analyse and critically evaluate different technical/ architectural solutions. • To integrate knowledge critically and systematically. • To clearly present and discuss the conclusions as well as the knowledge and arguments that • form the basis for these findings in written and spoken Enaglish. • A consciousness of the ethical aspects of research and development work.
7	**Voraussetzungen für die Teilnahme**	Prerequisites recommended: Deep Learning ML Prof. Dr. Andreas Maier 2+2 5 x E Pattern Recognition ML Prof. Dr. Andreas Maier 3+1+2 5 x E Maschinelles Lernen für Zeitreihen ML Prof. Eskofier, Prof. Oliver Amft, Dr. Ch. Mutschler 2+2+2 7.5 x E
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Seminar Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Seminarleistung We will meet in the beginning of the semester to discuss possible work areas and assign concrete topics to each participant. Participants will be provided pointers to literature, and then be expected to independently familiarize themselves with the assigned topic. Participants will then:

		• present an initial 3-minute pitch about their topic early during the term after topic selection • present your topic as a 20-minute presentation at the end of the term • submit a written report of approximately 8-10 pages. The seminar will be held in English including presentations and the written report. The long presentations will be conducted as a block seminar towards the end of the semester. The weekly hours mentioned in the module description are an optional time slot to get support, guidance and feedback on the participants' topics (as required).
11	**Berechnung der Modulnote**	Seminarleistung (100%)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 30 h Eigenstudium: 120 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	A specific reading list will be established at the beginning of each term, general literature is listed below: Quinn J, McEachen J, Fullan M, Gardner M, Drummy M. Dive into deep learning: Tools for engagement. Corwin Press; 2019 Jul 15. https://d2l.ai/ Goodfellow I, Bengio Y, Courville A, Bengio Y. Deep learning. Cambridge: MIT press; 2016 Nov 18. https://www.deeplearningbook.org/ Budd S, Robinson EC, Kainz B. A survey on active learning and human-in-the-loop deep learning for medical image analysis. arXiv preprint arXiv:1910.02923. 2019 Oct 7. https://arxiv.org/abs/1910.02923

1	**Modulbezeichnung** 47366	**Seminar Digital Health Psychology** Seminar: Digital health psychology	**5 ECTS**
2	Lehrveranstaltungen	Seminar: Digital Health Psychology (2 SWS)	5 ECTS
3	Lehrende		

4	**Modulverantwortliche/r**	Luca Abel Prof. Dr. Björn Eskofier Veronika Ringgold
5	**Inhalt**	**This course is the former "Digital Psychology Lab", students who already passed this course cannot participate.** The interdisciplinary course "Digital Health Psychology" is designed for students of psychology and medical engineering. Current issues from the fields of digital health and stress research are addressed in groups. The goal of this research-oriented course is to strengthen the cooperation between the individual disciplines in order to make optimal use of mutual synergy effects. Students will use their individual skills learned during their studies in interdisciplinary teams to benefit from each other. In addition to the planning and execution of a research question as well as analysis of the results in groups, there will also be teaching units of the different disciplines during the semester (psychology: theoretical models and biological basis of stress, hypothesis-driven planning and execution of experiments, collection of biomarkers and their evaluation in the laboratory, inferential statistics; medical engineering: data analysis in Python, acquisition and processing of physiological signals, basics of machine learning). In addition, fundamentals of scientific work and research data management are taught. Topics covered include: - Overview of current issues in the field of machine learning and data analysis for stress research. - Best practices for presenting and writing up scientific results - Best practices for hypothesis-driven design and implementation of experimental and field studies
6	**Lernziele und Kompetenzen**	- Students will gain an understanding of the current developments at the intersection of digital health and Psychology. - Students will learn to independently research and present a topic in the context of digital health psychology independently and to present it. - Students will learn to identify opportunities, challenges, and limitations of machine learning and digital health in psychology. - Students will develop the ability to identify and understand relevant literature and present their findings in a structured manner. - Students will learn to present implementation and validation results in the form of a presentation and a scientific paper.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5

9	**Verwendbarkeit des Moduls**	Artificial Intelligence Seminar Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Seminarleistung Presentation (10min) + Written Report (8 pages)
11	**Berechnung der Modulnote**	Seminarleistung (100%) Presentation (25 %), Written Report (75 %)
12	**Turnus des Angebots**	nur im Wintersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

Artificial Intelligence Project

Students choose 1 module from the "AI Project" catalog.

1	**Modulbezeichnung** 43932	**Computational Imaging Project** Computational imaging project	**10 ECTS**
2	Lehrveranstaltungen	Projekt: Computational Imaging Project (8 SWS)	10 ECTS
3	Lehrende		

4	**Modulverantwortliche/r**	Prof. Dr. Florian Knoll
5	**Inhalt**	Individual or group projects in the area of computational methods in biomedical imaging. The projects range from theoretical analysis to practical implementations of approaches that have recently been published in the literature. Students can either propose their own topics or contact the lecturer for a list of available topics. The project can be done either as 10 ECTS or a 5 ECTS depending on the scope of the work and the study program. If you want to do a project in this semester, please write an email to Prof. Knoll at the beginning of the semester to discuss possible topics.
6	**Lernziele und Kompetenzen**	Students acquire and practice the skills to: • Read and discuss literature from the field of biomedical imaging • Implement approaches that are proposed in the literature • Run computational experiments and interpret and communicate their findings in lab meetings
7	**Voraussetzungen für die Teilnahme**	Recommended: Computational Magnetic Resonance Imaging Lecture and Medical Engineering II
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Project Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Praktikumsleistung The grade is determined by: 50% Software development of approaches from the literature. 25% Presentation of the software and the results in the lab group meeting. 25% Written documentation of the development in form of a project report (max 10 pages).
11	**Berechnung der Modulnote**	Praktikumsleistung (100%)
12	**Turnus des Angebots**	nur im Sommersemester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 240 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Deutsch Englisch
16	**Literaturhinweise**	An individual reading list will be established at the beginning of each project.

1	**Modulbezeichnung** 47629	**Neurotechnology Project** Project: Neurotechnology	**10 ECTS**
2	Lehrveranstaltungen	Praktikum: Neurotechnology Project (8 SWS)	-
3	Lehrende		

4	**Modulverantwortliche/r**	Prof. Dr. Tobias Reichenbach
5	**Inhalt**	Projekte im Bereich der künstlichen neuronalen Netzwerke, der Brain-Machine Interfaces (BCIs) und der neuronalen Prothesen. --- Projects in the field of artificial neural networks, brain-machine interfaces (BCIs) and neural prostheses.
6	**Lernziele und Kompetenzen**	Die Studierenden... - Können Prinzipien der Analyse neuronaler Signale benutzen - Können Informationstheorie zur Beschreibung neuronaler Aktivität anwenden - Können die Dynamik einzelner Neurone wie auch von neuronalen Netzwerken mathematisch beschreiben - Können Ansätze zur Konstruktion von Brain-Machine Interfaces (BCIs) implementieren - Können Konzepte zum Design neuronaler Prothesen anwenden --- The students... - can use principles of analysis of neural signals. - can apply information theory to describe neuronal activity. - can describe the dynamics of individual neurons as well as of neural networks mathematically. - can implement approaches to the construction of Brain-Machine Interfaces (BCIs). - can apply concepts to the design of neural prostheses.
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5

9	**Verwendbarkeit des Moduls**	Artificial Intelligence Project Bachelor of Science Artificial Intelligence 20242 This module can be used as a combination of M6.1 (Academic Lab) and M6.2 (Research Lab) in the Master's program Medical Engineering.
10	**Studien- und Prüfungsleistungen**	Praktikumsleistung Schriftlicher Bericht (50%) mündlicher Bericht (50%)
11	**Berechnung der Modulnote**	Praktikumsleistung (100%)
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 120 h Eigenstudium: 300 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Deutsch oder Englisch
16	**Literaturhinweise**	Dayan, Peter, and Laurence F. Abbott. *Theoretical neuroscience: computational and mathematical modeling of neural systems*. Computational Neuroscience Series, 2001. Gerstner, Wulfram, et al. *Neuronal dynamics: From single neurons to networks and models of cognition*. Cambridge University Press, 2014. Oweiss, Karim G., ed. *Statistical signal processing for neuroscience and neurotechnology*. Academic Press, 2010. Maurits, Natasha. *From neurology to methodology and back: an introduction to clinical neuroengineering*. Springer Science & Business Media, 2011. Clément, Claude. *Brain-Computer Interface Technologies*. Springer International Publishing, 2019. DiLorenzo, Daniel J., and Joseph D. Bronzino, eds. *Neuroengineering*. CRC Press, 2007.

1	**Modulbezeichnung** 47676	**Projekt Biomedical Network Science** Project: Biomedical network science	**10 ECTS**
2	Lehrveranstaltungen	Projekt: Projekt Biomedical Network Science (4 SWS)	10 ECTS
3	Lehrende	Prof. Dr. David Blumenthal Dr. Anne Hartebrodt	

4	**Modulverantwortliche/r**	Prof. Dr. David Blumenthal
5	**Inhalt**	The Biomedical Network Science (BIONETS) lab investigates molecular disease mechanisms using techniques from combinatorial optimization, network science, and artificial intelligence. We also develop privacy-preserving decentralized biomedical AI solutions, which enable cross-institutional studies on sensitive data. Students will work on individual research topics within these field and develop prototypes of software tools to solve the addressed problems.
6	**Lernziele und Kompetenzen**	Students will be able to • develop and implement an algorithm for a problem within the field of biomedical networks science which, in certain respects, improves upon the state-of-the-art, • apply best practices in software development and documentation, • write an academic report.
7	**Voraussetzungen für die Teilnahme**	Strong programming skills in any programming language.
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Project Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel Practical Achievement: Fully functional software prototype submitted as persistent source code repository + written report (4 pages double column) + oral presentation of software prototype.
11	**Berechnung der Modulnote**	Variabel (100%) Fully functional software prototype submitted as persistent source code repository (40%), written report (40%), oral presentation of software prototype (20%).
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 240 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	All relevant research literature will be made available in StudOn.

1	**Modulbezeichnung** 924553	**Projekt Maschinelles Lernen und Datenanalytik** Project machine learning and data analytics	**10 ECTS**
2	Lehrveranstaltungen	Sonstige Lehrveranstaltung: Projekt Maschinelles Lernen und Datenanalytik (2 SWS)	10 ECTS
3	Lehrende		

4	**Modulverantwortliche/r**	Prof. Dr. Björn Eskofier An Nguyen Dr. Dario Zanca
5	**Inhalt**	At the Machine Learning and Data Analytics Lab we offer project topics that are related to our current research in the fields of Machine Learning, Human Computer Interaction, Modeling and Simulation and Wearable Computing. Other than a course with fixed topic, project topics are defined individually. The 10 ECTS project addresses students of computer science and medical engineering. However, most projects can also be offered as 5 ECTS medical engineering internship/praktikum. There will be a kick-off meeting the first Thursday 16:15-18:00 of each semester where topics in the field of machine learning and data analytics will be presented. Most topics will be related to the diverse research fields of the Machine Learning and Data Analytics Lab. Students also have the possibility to discuss their own project ideas with the supervisors. The distribution of topics will be based on prerequisites and first come, first serve in terms of time of registration until all topics are distributed. Students will have to contact the corresponding supervisor for the topic of interest. Additional topics are also presented on our website.
6	**Lernziele und Kompetenzen**	The students • work on a machine learning algorithm and implement it • work on complex software systems and expand them • learn to independently develop and implement proposed solutions • document the software they have written
7	**Voraussetzungen für die Teilnahme**	Keine
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Project Bachelor of Science Artificial Intelligence 20242 No prerequisites for this course.
10	**Studien- und Prüfungsleistungen**	Portfolio The evaluation for projects includes a code repository with the implementation of the work (including proper code documentation), a 15-minute presentation, and a term paper of approximately 10 pages.
11	**Berechnung der Modulnote**	Portfolio (100%) The overall grade consists of these parts: • 50% graded implementation

		• 25% graded presentation • 25% graded documentation/report
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 240 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Deutsch Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 93112	**Project Representation Learning** Project: Representation learning	**10 ECTS**
2	Lehrveranstaltungen	Projekt: Project Representation Learning (8 SWS) yes for final presentations and meetings	10 ECTS
3	Lehrende		

4	**Modulverantwortliche/r**	Prof. Dr. Bernhard Kainz
5	**Inhalt**	At the Image Data Exploration and Analysis Lab we offer project topics that are connected to our current research in the fields of medical image processing, machine learning, human-in-the-loop computing, and computer vision. Other than a course with fixed topic, project topics are defined individually. The 10 ECTS project is directed towards students of computer science and medical engineering. Please have a look at our website for an overview. https://www.idea.tf.fau.eu/teaching/open-projects/ Different projects in the area of (deep) representation learning are on offer. These reach from theoretical exploration of new data representation methods to practical evaluation of applications in, e.g., medical image analysis. Furhter example projects will be made available on the website of the Image Data Exploration and Analysis Lab. Students may also propose their own projects, which will be coordinated and refined with the module lead during preliminary discussions.
6	**Lernziele und Kompetenzen**	The students work their way into complex software systems and expand them learn to develop and implement solutions independently document the software they have written. We'll start with a project definition phase, followed by literature research, idea outline and implementation phase. Final results will be presented in a mini-symposium and further explained in a short 10-page scientific report. **Module aims** In this module you will have the opportunity to demonstrate independence and originality, to plan and organise a large project over a long period, and to put into practice the knowledge, skills and research methods that you have learnt throughout the course. **Learning outcomes** Upon successful completion of this module, you will have demonstrated your ability to: - apply previously taught knowledge and skills to a substantial problem in Computing or Data Science, as an individual - conduct an independent investigation and apply cutting-edge research, methods and thinking appropriate to the problem - present complex technical material orally to a mixed audience

		- exercise scientific writing skills by way of a substantial written report, summarising your findings **Module syllabus** There will be a small number of supporting meetings that will 1. describe the structure of the project, including expectations, milestones and deliverables, 2. give guidance on writing and presentation skills targeted specifically at individual projects, 3. explain the assessment procedures. The rest of the project involves an independent investigation under the supervision of an academic advisor.
7	**Voraussetzungen für die Teilnahme**	You should have very solid programming skills and have knowlege in machine learning, deep learning and computer vision methods.
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Project Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel The deliverables include a written report (10 pages) and a presentation (20 minutes)
11	**Berechnung der Modulnote**	Variabel (100%) The grade consists of the written report (80%) and the presentation (20%).
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 240 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 47594	**Research Project on Surgical Robotics** Research project: Surgical robotics	**10 ECTS**
2	Lehrveranstaltungen	Praktikum: Research Project on Surgical Robotics (4 SWS)	10 ECTS
3	Lehrende	Pit Henrich Prof. Dr. Franziska Mathis-Ullrich	

4	**Modulverantwortliche/r**	Prof. Dr. Franziska Mathis-Ullrich
5	**Inhalt**	At Surgical Planning and Robotic Cognition (SPARC) Laboratory, we focus on various research projects in the field of minimally invasive surgical robotics, cognitive robot-assisted surgery, and assistance systems for the operating room (e.g., augmented reality). Within this scope, applications and systems are developed, which are often (pre-)clinically tested in collaboration with medical partners in order to enable translation of the technologies into practice. Through this research project, students will gain hands-on experience and insight into the use of computer science and engineering in medical robotics and its applications. Depending on the advertised project, this internship will involve working alone or in teams of 2 to 3 students on a task that addresses current research topics at the SPARC lab. Due to the interdisciplinary nature of the field of medical robotics, research projects with a focus on hardware development as well as those with a focus on software development are offered. Details, as well as required prior knowledge, are noted on the respective project announcements.
6	**Lernziele und Kompetenzen**	Students • are able to solve a practical problem from the field of medical robotics independently. • understand the underlying medical problem/challenge. • gain practical skills in the use of hardware and software in the field of surgical robotic systems and according measurement and control technology. • are able to specify and implement hardware and software required to solve a given problem. • apply basic knowledge to a problem and develop solution strategies. • are able to solve a problem alone or as part of a team • have knowledge of the phases of a project, time, and resource management. • are confident in the use of software development tools, source code management, and documentation. • are able to convey complex technical content in a scientific presentation.
7	**Voraussetzungen für die Teilnahme**	Recommended: basic maths, programming skills, machine learning.

8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Project Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Variabel In addition to the written report in the style of a scientific publication (4-5 pages), the continuous processing of the project tasks is assessed (coursework).
11	**Berechnung der Modulnote**	Variabel (100%) Coursework: 85% Written report: 15% both must be passed
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 30 h Eigenstudium: 120 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	

1	**Modulbezeichnung** 92413	**Project Assistive Intelligent Robotics**	**10 ECTS**
2	Lehrveranstaltungen	Zu diesem Modul sind keine Lehrveranstaltungen oder Lehrveranstaltungsgruppen hinterlegt!	
3	Lehrende	Zu diesem Modul sind keine Lehrveranstaltungen und somit auch keine Lehrenden hinterlegt!	

4	**Modulverantwortliche/r**	Prof. Dr. Claudio Castellini
5	**Inhalt**	In the Assistive Intelligent Robotics Lab (AIROB, see https://www.airob.tf.fau.de/) we are interested in translating to rehabilitation ideas, concepts, mechanisms, control systems, interaction strategies and ways to detect a patient's intention. We focus on prostheses, exoskeletons and exo-suits as well as fully fledged robotic arms and virtual reality; we also focus on interactive machine learning, sensors and the signals they provide, the physical attachment of sensors and actuators to the human body, and functional assessment. Somato-sensory feedback is, lastly, of great interest to us. Students will first get a thorough introduction to our topics and a practical hand-on one- or two-weeks course, then work on individual small research topics within this field and develop prototypes to solve the addressed problems.
6	**Lernziele und Kompetenzen**	Students will • develop and implement an algorithm for a problem within the field of rehabilitation and assistive robotics which might lead in some circumstances to an improvement to the state-of-the-art, • acquire hands-on experience in an emerging research field, • learn best practices in software development and documentation, • gain first experience in academic writing.
7	**Voraussetzungen für die Teilnahme**	Recommended: • some basics in signal processing.
8	**Einpassung in Studienverlaufsplan**	Semester: 5
9	**Verwendbarkeit des Moduls**	Artificial Intelligence Project Bachelor of Science Artificial Intelligence 20242
10	**Studien- und Prüfungsleistungen**	Praktikumsleistung Written summary and Powerpoint presentation of the completed tasks in the style of a scientific publication, e.g., as a co-author of an actual publication or as a written report of 4 to 6 pages.
11	**Berechnung der Modulnote**	Praktikumsleistung (100%) The grade is formed from the Report (50 %) and the Presentation (50 %).
12	**Turnus des Angebots**	in jedem Semester
13	**Arbeitsaufwand in Zeitstunden**	Präsenzzeit: 60 h Eigenstudium: 300 h

14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Englisch
16	**Literaturhinweise**	