Ausgewählte Kapitel der Embedded Systems (5071038)

Englischer Titel	Selected Topics in Embedded Systems					
Art des Moduls	Wahlpflichtmodul		**Modulverantwortliche(r)**		Prof. Dr. Arndt Balzer	
Dozent(in)	Prof. Dr. Arndt Balzer					
Sprache	Deutsch/Englisch		**Studiensemester**		2	
SWS	4		**Lehr- und Lernformen**		Seminar	
ECTS-Punkte	5		**Art der Prüfung**		Referat, Kolloquium	
Bonusleistungen						
Arbeitsaufwand	**Gesamt**	150	**Präsenzzeit**	60	**Selbststudium**	90
Dauer	1 Semester		**Angeboten**		Wintersemester	
Art der Note	Differenzierte Note		**Verwendbarkeit**		Artificial Intelligence, Digital Business Systems	
Voraussetzungen nach SPO	keine					
Empfohlende Voraussetzungen						
Lernergebnis des Moduls	Die Studierenden sind in der Lage - Notwendigkeit, Marktrelevanz und das Potential Eingebetteter (mobiler) Systeme zu bewerten, - Herausforderungen bei Bau autonomen fahrender Systeme beurteilen und Lösung entwerfen zu können, - Aufbau und Funktionsweise der Hard- und Software von Regelungssystemen am Beispiel eines Quadrokopters zu beschreiben, einschließlich der Echtzeitanforderungen, - Teile der Systemsoftware zu implementieren, - eingesetzte mathematische Methoden zu beurteilen, - Ansätze zur Verbesserung der Signalverarbeitung zu entwerfen.					
Inhalte des Moduls	Die Inhalte der Lehrveranstaltung werden aktuellen Erfordernissen angepasst. Seit 2020 ist der Schwerpunkt die Entwicklung von Software für ein autonom fahrendes Fahrzeug auf Basis von NVIDIA Hardware Grundlagen des maschinellen Lernen, dabei u.a. künstliche neuronale Netze Maschinelles Sehen, \\\"klassische\\\" Bildverarbeitung Bis 2019 war der Schwerpunkt: Entwicklung von Software zur Steuerung eines Quadrokopters Programmierung von Embedded Systems Regelungstechnik, insbesondere PID Regler Sensorik, Telemetrie Mathematische Grundlagen: Kartesische und Polar Koordinaten, Euler Winkel, komplexe Zahlen, Quaterionen, Vektoralgebra Signalverarbeitung: Zustandsschätzer, Bayes-, Gauss-, Kalman-Filter Lageregelung, Yaw Regelung, Telekommandos Bei Bedarf: Entwicklung von Software für MCU mit aktuellen IDEs, teil-autonomes Fahren					
Literatur	Tom M. Mitchell, Machine Learning, http://www.cs.cmu.edu/~tom/mlbook.html Christopher M. Bishop, Pattern Recognition and Machine Learning, online Trevor Hastie et al., The Elements of Statistical Learning, online Kevin P. Murphy, Machine learning, online S. Thrun, W. Burgard, D. Fox: Probabilistic Robotics, The MIT Press, 2005 Unterlagen der Uni Würzburg / Emqopter, 2019 A. Gelb, Applied Optimal Estimation, MIT Press, 1974 R. Kalman, A New Approach to Linear Filtering and Prediction Problems, Transaction of the ASME—Journal of Basic Engineering, 1960 P. Marwedel: Embedded System Design - Foundations of Cyber-Physical Systems, Springer, 2011 D. Gajski, F. Vahid: Specification and Design if Embedded Systems, Pearson, 2008 J. McClellan. R. Schafer: Signal Processing First, Pearson, 2003					

Trustworthy AI and AI regulations (5171070)

Module name english	Trustworthy AI and AI regulations					
Type of module	Pflichtmodul		**Responsible for module**		Prof. Dr. Oliver Ehret	
Lecturer	Prof. Dr. Oliver Ehret, Prof. Dr. Christian Kraus					
Language of instruction, L. of examination	Englisch		**Semester**		2	
SWS	4		**Teaching and learning formats**		Seminaristischer Unterricht	
ECTS-Credits	5		**Type of examination**		Schriftliche Prüfung (90 Min.)	
Bonus benefits						
Workload	**Workload (Total)**	150	**Attendance time**	60	**Self-Study time (incl. exam preparation)**	90
Duration of module	1 Semester		**Frequency**		Wintersemester	
Type of grading	Differenzierte Note		**Verwendbarkeit**		Artificial Intelligence	
Conditions for participation	None					
Recommended prerequisites						
Module's learning outcomes	On successful completion of this module, the learner should be able to: - Understand the challenges of AI systems to existing law - Be able to place AI systems – from a legal standpoint - in civil and intellectual property law - Discuss AI-systems and the risks they are involving in self-driving cars - Outline the role of the selected principles in the context of AI - Evaluate the attempts of regulating AI within the EU to close possible legal gaps - Understand the ongoing measures to give AI systems a place in the legal system - Explain different ethical schools of thought and distinguish their lines of argumentation - Assess the challenges associated with technical innovations against the background of moral values - Evaluate selected applications and dilemmas and argue stringently					
Module content	1. Part Law 1.1. Introduction to law 1.2. AI systems and civil law, e.g. can AI act legally (e.g. by the vicarious agent or proxy) or creating a legal capacity of autonomous systems 1.3. Civil liability of AI systems 1.4. AI and intellectual property 2. Part Ethics 2.1. What is ethics? 2.2. Fairness and trust in AI systems 2.3. Responsibility and liability for AI systems 2.4. Risks of AI for companies 2.5. Human Enhancement 2.6. Autonomous vehicles 2.7. Military applications of AI					

Literature	Bartneck, Christoph, Christoph Lütge, Alan R. Wagner, und Sean Welsh. Ethik in KI und Robotik. München: Hanser, 2019. Coeckelbergh, Mark. AI ethics. The MIT press essential knowledge series. Cambridge, MA: The MIT Press, 2020. Darwall, Stephen L. Philosophical ethics. Dimensions of philosophy series. Boulder, Colo: Westview Press, 1998. European Commission High-level expert group on artificial intelligence, Hrsg. „Ethics guidelines for trustworthy AI“, 8. April 2019. https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai. Loh, Janina. Roboterethik: eine Einführung. Erste Auflage, Originalausgabe. suhrkamp taschenbuch wissenschaft 2277. Berlin: Suhrkamp, 2019. Lütge, Christoph, Hrsg. Handbook of the philosophical foundations of business ethics. Springer reference. Dordrecht?; New York: Springer, 2013. Simanowski, Roberto. Todesalgorithmus: das Dilemma der künstlichen Intelligenz. Deutsche Erstausgabe, 2., Durchgesehene Auflage. Passagen Thema. Wien: Passagen Verlag, 2021. Sparrow, Robert. „Robots and Respect: Assessing the Case Against Autonomous Weapon Systems“. Ethics & International Affairs 30, Nr. 1 (2016): 93–116. https://doi.org/10.1017/S0892679415000647. Taddeo, Mariarosaria, David McNeish, Alexander Blanchard, und Elizabeth Edgar. „Ethical Principles for Artificial Intelligence in National Defence“. Philosophy & Technology, 13. Oktober 2021. https://doi.org/10.1007/s13347-021-00482-3. Wallach, Wendell, und Colin Allen. Moral Machines: Teaching Robots Right from Wrong. First issued as an Oxford University Press paperback. New York, NY: Oxford University Press, 2010. Robbers, An Introduction to German Law, 7. Ed., 2019, Nomos. Barfield and Pagallo, Law and artificial intelligence, 2020, Edward Elgar Publishing Limited. Eidenmüller and Wagner, Law by algorithm, 2021, Mohr Siebeck Tübingen

Semantic data processing and representation (5171090)

Module name english	Semantic data processing and representation					
Type of module	Pflichtmodul		**Responsible for module**		Ivan Yamshchikov	
Lecturer	Ivan Yamshchikov					
Language of instruction, L. of examination	Englisch		**Semester**		2	
SWS	4		**Teaching and learning formats**		Seminaristischer Unterricht	
ECTS-Credits	5		**Type of examination**		Portfolio	
Bonus benefits						
Workload	**Workload (Total)**	150	**Attendance time**	30	**Self-Study time (incl. exam preparation)**	120
Duration of module	1 Semester		**Frequency**		Wintersemester	
Type of grading	Differenzierte Note		**Verwendbarkeit**		Artificial Intelligence	
Conditions for participation	None					
Recommended prerequisites						
Module's learning outcomes	After successfully completing the module: • students are able to apply the basic methods of Natural Language Processing and related applications. The students are able to develop result-oriented applications that integrate Natural Language Processing methods. These methods can be based in whole or in part on various forms of artificial neural networks (deep neural networks). • students are able to analyse concrete tasks in the field of natural language processing from applied science or industrial practice and evaluate and select suitable methods and software components from the field of natural language processing. In particular, students are also able to describe and develop suitable Deep Learning architectures. • students are also able to describe, implement and present a corresponding overall software architecture. In doing so, they draw on common frameworks from the field of deep learning (e.g. KERAS, TensorFlow, PyTorch, etc.). They organise themselves and their team independently in the application of learned methods of Natural Language Processing.					
Module content	— Introduction and Natural Language Processing Applications — Text and Speech Basics — Reading scientific papers — Tokenization — Embeddings — Verbal Intelligence — Semantic Representations — Distributed Representations / Word Embeddings — Language Models — Transformers — Large Language Models — Frontiers of modern NLP The model is implementing a learning-by-doing approach. The students read a variety of scientific publications that are fundamental for the topic, present and discuss these contributions as the course unfolds.					
Literature	• Kamath, Uday, John Liu, and James Whitaker. Deep learning for NLP and speech recognition. Vol. 84. Cham: Springer, 2019. • Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: May 1999.					

Learning of structured data (5171100)

Module name english	Learning of structured data				
Type of module	Pflichtmodul		**Responsible for module**	Prof. Dr. Frank-Michael Schleif	
Lecturer	Prof. Dr. Frank-Michael Schleif				
Language of instruction, L. of examination	Englisch		**Semester**	2	
SWS	4		**Teaching and learning formats**	Seminaristischer Unterricht	
ECTS-Credits	5		**Type of examination**	Portfolio	
Bonus benefits					
Workload	**Workload (Total)**	150	**Attendance time** 60	**Self-Study time (incl. exam preparation)**	90
Duration of module	1 Semester		**Frequency**	Wintersemester	
Type of grading	Differenzierte Note		**Verwendbarkeit**	Artificial Intelligence	
Conditions for participation	None				
Recommended prerequisites					
Module's learning outcomes	- being able to evaluate and to apply modelling techniques for non-standard data - being able to analyse non-vectorial data and to derive and improve predictive models - knowing how to evaluate and assess respective representation techniques - being able to implement pipelines for non-vectorial data analysis - learn the how-to of proximity based learning - learn how to assess, use and potentially extend the respective frameworks - Students know how to characterize, choose, evaluate, assess and construct practical tools for structured data analysis and respective application fields - learn how to use scientific literature and to understand, derive, implement and potentially extend the presented methods				
Module content	The module explains the generic analysis and processing of non-vectorial or structured data like graphs, trees, sequential data or alike. We discuss algebraic methods as well as neural network based techniques. The algorithmic part is shown in matlab, numpy/python or by use of other numerical frameworks. Exemplary the following key topics are addressed: - Particularities of non-vectorial, compositional and structured data - General proximity measures and implications on mathematical models - Mathematical concepts like information theoretic measures,non-euclidean spaces, local and global embedding approaches - Representation by proximity measures and simple learning methods - Particular algebraic and neural network based Embedding techniques - Evaluation methods for the representation of non-vectorial data - Exemplary implementations and applications				
Literature	- The Dissimilarity Representation for Structural Pattern Recognition, Pekalska & Duin, World Scientific, 2005 - Graph Classification And Clustering Based On Vector Space Embedding, Bunke et al., 2010 - Kernels For Structured Data, Gartner, 2008 - Graph Representation Learning, Hamilton, 2020 - Recent publications on learning of structured data are provided / suggested during the lecture				

Scientific seminar (5171110)

Module name english	Scientific seminar					
Type of module	Pflichtmodul		**Responsible for module**		Prof. Dr. Magda Gregorová	
Lecturer	Prof. Dr. Magda Gregorová					
Language of instruction, L. of examination	Englisch		**Semester**		2	
SWS	4		**Teaching and learning formats**		Seminar	
ECTS-Credits	5		**Type of examination**		Portfolio	
Bonus benefits						
Workload	**Workload (Total)**	150	**Attendance time**	60	**Self-Study time (incl. exam preparation)**	90
Duration of module	1 Semester		**Frequency**		Wintersemester	
Type of grading	Differenzierte Note		**Verwendbarkeit**		Artificial Intelligence	
Conditions for participation	None					
Recommended prerequisites						
Module's learning outcomes	Upon completion of the seminar students: • can write English academic texts on AI topics taking into account the expected format (using appropriate mathematical typographical software - LaTex), structure, and the target audience; can adapt the language and visual support accordingly (article vs. presentation, etc.). • understand the importance of good academic conduct, the boundaries and consequences of plagiarism, and the benefits of open science, transparency and reproducibility, they can design their communication strategy accordingly (open access / open source, experimental documentation, etc.) • can conduct relevant literature search, analyze the quality of texts, can create and maintain a relevant bibliography in standard software tools and correctly reference previous work in their academic outputs • are aware of selected recent trends in AI research and main opportunities and challenges in transferring them to practical applications • can critically analyse academic text and provide constructive feedback, can interact with senior researchers in an informed discussion					
Module content	Note: In summer semester 2023 exceptionally 2 SWS of the seminar has been offered. The remaining 2 SWS will be offered in winter semester 2023/24. Practical research and scientific work skills and principles of good scientific conduct. • Academic writing on AI topics in English (for non-native speakers) - Standard structure of academic texts – theses, technical reports, research articles, academic CV - Specific grammar features and word choices of English academic text and common pitfalls for non-native speakers - Good conduct in academic writing (citations, acknowledgments, plagiarism), open science, transparency, reproducibility - Literature review (dblp, google scholar, journals and conferences, predatory publishers) - Visual support of technical text (visual display of quantitative data, visual communication), academic presentations and poster design - Analysis of academic text, critical evaluation, peerreview process and principles • Academic and research support software tools - Bibliography systems (Zotero, Mendeley, …) - Text editing with LaTex - Software development and versioning (Git, GitHub, Bitbucket, etc.) The seminar will be enriched by a series of invited talks delivered by external academic researchers and/or AI practitioners. Through these the students will learn about: • Current trends and topics in AI research and applications - Transferability of theoretical research results to practical applications - Opportunities, open questions and challenges for AI research and applications (technical, societal, ethical, etc.) - Academic talk structure, audience targeting, academic exchange of knowledge and experience, constructive feedback and academic research discussion - Networking, establishing and fostering collaborations, formal/ informal interaction with senior researchers and practitioners					
Literature	To be defined in seminar					

Mathematical Finance and Machine Learning (5171517)

Module name english	Mathematical Finance and Machine Learning					
Type of module	Wahlpflichtmodul		**Responsible for module**		Ivan Yamshchikov	
Lecturer	Ivan Yamshchikov					
Language of instruction, L. of examination	Englisch		**Semester**		2	
SWS	4		**Teaching and learning formats**		Seminar	
ECTS-Credits	5		**Type of examination**		Portfolio	
Bonus benefits						
Workload	**Workload (Total)**	150	**Attendance time**	60	**Self-Study time (incl. exam preparation)**	90
Duration of module	1 Semester		**Frequency**		Unregelmäßig	
Type of grading	Differenzierte Note		**Verwendbarkeit**		Artificial Intelligence	
Conditions for participation	none					
Recommended prerequisites						
Module's learning outcomes	The educational outcomes are as follows. The student that successfully completed the course: — understands fundamental mathematical properties of financial markets — can conceptualise an approach for pricing a new financial tool — has deep understanding of the underlying mathematical principles that are essential for financial markets — can apply those ground principle in practice — can model an empirically observed financial product using machine learning methods					
Module content	The course is dedicated Financial Markets and tools that one can apply to the analysis of the financial data. The course consists of two components: a component on financial markets and a component on the applications of machine learning to financial markets. We start with an overview of standard methods of Mathematical Finance and develop deep theoretical understanding of the stochastic processes behind them. This include: — Notion of Stochastic Processes — Geometric Brownian Motion — Self-financing strategy — Black-Scholes Formula — Greeks — Factor models on incomplete markets — Pricing with dividends — Bond pricing and yield curve — Time series analysis (ARIMA, SARIMA, ARCH, GARCH etc.) — Hamilton-Jacobi-Bellmann Equaltion The second part of the course covers a set of empirically-driven data analysis approaches to financial modelling and decision making under time pressure. The practical aspects of the course include: — processing real financial time series — creating a game strategy for a Texas hold'em Poker bot tournament, where the bots created by the participants compete with one another — analysis of cryptocurrency price dynamics with methods for time series analysis					
Literature	T. Björk, \\"Arbitrage Theory in Continuous Time\\" M.L. De Prado \\"Advances in Financial Machine Learning\\"					

Project Module II (5172060)

Module name english	Project Module II					
Type of module	Pflichtmodul		**Responsible for module**		Prof. Dr. Magda Gregorová	
Lecturer	Prof. Dr. Frank-Michael Schleif, Prof. Dr. Magda Gregorová, Prof. Dr. Pascal Meißner					
Language of instruction, L. of examination	Englisch		**Semester**		2	
SWS	4		**Teaching and learning formats**		Projekt	
ECTS-Credits	5		**Type of examination**		Portfolio	
Bonus benefits						
Workload	**Workload (Total)**	150	**Attendance time**	60	**Self-Study time (incl. exam preparation)**	90
Duration of module	1 Semester		**Frequency**		Wintersemester	
Type of grading	Differenzierte Note		**Verwendbarkeit**		Artificial Intelligence	
Conditions for participation	None					
Recommended prerequisites						
Module's learning outcomes	Students can methodically process and solve comprehensive tasks. The students can develop and implement suitable solution strategies in a team. They know how team processes work and can assess how to contribute their own personality. The students can independently set up, implement, accompany and present a small AI project in a team. They can select and use appropriate development technologies and test and document their code.					
Module content	The students will work in groups to solve projects using AI techniques (supervised by at least one professor). The topics are provided by professors of the FIW, other faculties or external partners. In general the project will contain a software development (potentially accompanied by a technical solution) and a respective documentation or other form or presentation.					
Literature	1. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, A.Geron, O'Reilly, 2019 2. The Data Science Design Manual, S. Skiena, Springer, 2017 3. Deep Learning, I. Goodfellow, MIT Press, 2016 Further literature will be given based on the respective project tasks.					

Fundamentals of Mobile Robotics (5172080)

Module name english	Fundamentals of Mobile Robotics				
Type of module	Pflichtmodul		**Responsible for module**	Prof. Dr. Pascal Meißner	
Lecturer	Prof. Dr. Pascal Meißner				
Language of instruction, L. of examination	Englisch		**Semester**	2	
SWS	4		**Teaching and learning formats**	Seminaristischer Unterricht	
ECTS-Credits	5		**Type of examination**	Mündliche Prüfung	
Bonus benefits					
Workload	**Workload (Total)**	150	**Attendance time** 60	**Self-Study time (incl. exam preparation)**	90
Duration of module	1 Semester		**Frequency**	Wintersemester	
Type of grading	Differenzierte Note		**Verwendbarkeit**	Artificial Intelligence	
Conditions for participation	None				
Recommended prerequisites					
Module's learning outcomes	• Apply the Bayes (filter) formula and sample from probability density functions • Determine and apply probabilistic sensor and motion models • Discuss the steps and components of realizations of Bayes filters • Implement realizations of Bayes filters and compute location estimates for robots • Build and analyze grid maps • Differentiate between localization and SLAM systems as well as outline auxiliary techniques for SLAM solutions • Assess and implement components of landmark- and grid-based solutions to the SLAM problem • Differentiate between different path planning techniques and discuss the steps of collision avoidance solutions • Apply and implement graph-search techniques for path planning • Assess the Markov Decision Process definition as well as the concepts of Utility and Policy • Apply dynamic programming on Markov Decision Problems to compute value functions and optimal policies				
Module content	01. Introduction – Nomenclature, history, state of the art, module logistics 02. Linear Algebra and Probability Primer – Vectors and operations, matrices and operations, axioms of probability, independent events, Bayes rule 03. Bayes Filter – Recursive Bayesian updating, state transitions, Markov property, derivation 04. Probabilistic Modelling – Odometry- and velocity-based motion models, beam- and scan- based sensor models 05. Localization with Nonparametric Filters – Discrete Bayes filter, importance sampling, particle filter 06. Localization with Gaussian Filters – Kalman filter, Extended Kalman filter 07. Mapping with Known Poses – Occupancy maps, reflection probability maps 08. Landmark-based SLAM – SLAM problem, EKF SLAM, loop closing, Rao-Blackwellization, FastSLAM 09. Grid-based SLAM – Scan matching, FastSLAM, improved proposals, selective resampling 10. Motion and Path Planning – Configuration spaces, combinatorial planning, search algorithms, A* with extensions, collision avoidance 11. Markov Decision Processes – MDP definition, utility, value iteration, policy iteration				
Literature	• Probabilistic Robotics, Sebastian Thrun and Wolfram Burgard and Dieter Fox, MIT Press, 978-0262201629, 2005 • Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 4th ed. Prentice Hall, 978-0136042594, 2021				