Module im Bereich: Learning Methods and Models for Data Science

- Advanced Topics in Deep Learning (Master)
- Applied Discrete Modelling
- Data Mining II - Advanced Topics in Data Mining
- Evolutionary Multi-Objective Optimization
- Introduction to Deep Learning
- Introduction to Machine Learning Safety
- Learning Generative Models
- Neuro-Symbolic Integration
- Recommenders
- Seminar 'Advanced Topics of KMD'
- Seminar on Advanced Topics of Predictive Maintenance
- Swarm Intelligence
- Wissenschaftliches Individualprojekt

Advanced Topics in Deep Learning (Master)

every

(in German: Advanced Topics in Deep Learning (Master))

Module-ID: FIN-INF-120496

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
ATDL	6	every	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	
Responsibility:	Sebastian Stober
Lecturer:	Sebastian Stober
Classes:	*Advanced Topics in Deep Learning*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DKE: Data Processing for Data Science - M.Sc. DKE: Applied Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. VC: Computer Science

Intended learning outcomes:
Students ...

- can read and analyze current research papers
- apply deep learning to an application domain
- gain in-depth knowledge In the application domain

- learn to work efficiently in a team on scientific problems
- learn to work on a server infrastructure
- present scientific results in a written and oral form

Content:

- Current topics from deep learning research
- Create domain-specific deep learning pipelines
- The application domain will be announced beforehand

Workload:

- 30h in person
- 150h self-study

Pre-examination requirements:	Type of examination:	Teaching method / lecture hours per week (SWS):
	• Hausarbeit • Mündliche Prüfung	Vorlesung/Seminar (2 SWS)

Prerequisites according to examination regulations:	Recommended prerequisites:
none	Introduction to Deep Learning

Media:	Literature:

Comments:

Applied Discrete Modelling

Winter

(in German: Applied Discrete Modelling)

Module-ID: FIN-INF-120279

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
ADM	6	Winter	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	
Responsibility:	PD Dr. Claudia Krull
Lecturer:	PD Dr. Claudia Krull
Classes:	• Lecture *Applied Discrete Modelling* • Exercise class *Applied Discrete Modelling*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INF: Informatik Wahlpflicht (SPO 2027) - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. WIF: Informatik Wahlpflicht (SPO 2027) - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Fachliche Spezialisierung - M.Sc. DE: Informatik Wahlpflicht (SPO 2027) - M.Sc. VC: Computer Science - M.Sc. VC: Computer Science (SPO 2027)

Intended learning outcomes:

- Students understand the basics of Markov chains and know selected applications and solution methods

- Students understand non-Markovian stochastic processes and can model and simulate them in different ways
- Students understand hidden Markovian and non-Markovian processes
- Students know selected research topics of the research group
- Students can implement the models and methods they have learned and apply them to problems from the university's main research areas, in particular medicine and engineering

Content:

- Discrete-time and continuous-time Markov chains
- Applications and implementation of solution methods for Markov chains
- Method of supplementary variables
- Proxel simulation and phase distributions
- Modeling with hidden models
- Programming solution methods for different model classes
- Modeling and solving problems from medicine and engineering

Workload:
56 h lectures and exercise classes
124 h independent work

Pre-examination requirements:	**Type of examination:**	**Teaching method / lecture hours per week (SWS):**
Solutions to Assignments 1-6 need to be handed in before the exam registration.	Oral Exam 30 Minutes	• Lecture 2 SWS • Exercise class 2 SWS

Prerequisites according to examination regulations:	**Recommended prerequisites:**
none	• Engineering mathematics • Computer programming

Media:	**Literature:**
recorded lectures and exercises are available	

Comments:

Data Mining II - Advanced Topics in Data Mining

Winter

(in German: Data Mining II - Advanced Topics in Data Mining)

Module-ID: FIN-INF-120455

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
DM2	9	Winter	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	false
Responsibility:	Myra Spiliopoulou
Lecturer:	Myra Spiliopoulou
Classes:	Vorlesung DM 2 Übung DM 2 **COURTESY TRANSLATION:** • Lecture class DM2 • Exercise class DM2
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. DE: Fachliche Spezialisierung - M.Sc. VC: Computer Science

Intended learning outcomes:
When successfully completing this module, the students:

- comprehend why temporal data need different learning algorithms and evaluation procedures than used on static data
- comprehend the behaviour of supervised, unsupervised and semi-supervised learning algorithms on temporal data
- can design and apply simple learning algorithms and workflows on temporal data and interpret the induced models
- can evaluate models - once and in continuous evaluation, since both are needed in temporal learning

and have thus acquired skills they need in order to design and evaluate temporal learning algorithms themselves

Content:
Block 1A: Data Streams

- Basics
- Stream classification: learning methods and concept drift detectors; evaluation approaches
- Semi-supervised stream learning: methods and evaluation approaches

Block 1B: Time series

- Basics
- Time series classification
- Time series prediction
- Evaluation of models

Block 2: discussion of papers (inverted classroom) and hands-on of algorithms (in the exercises)
Workload:

- 28 hours - in presence : lecture class (2 hours per week)
- 28 hourse in presence: exercise class (2 hours per week)
- 214 Stunden: Individual working time on
  - Preparation for lectures and exercise classes
  - Reading and understanding the articles (scientific papers) provided for the discussion in the lecture class

Pre-examination requirements:	**Type of examination:**	**Teaching method / lecture hours per week (SWS):**

Votierung in der Vorlesung und in der Übung (A minimum number of points must be achieved in Block 1 and in Block 2)	Schriftliche Prüfung - Klausur **COURTESY TRANSLATION:** • Written exam of the form 'Klausur' • Prerequisite for the written exam: a minimum number of points must be achieved; this procedure is called 'Votierung'	• Vorlesung (2 SWS) • Übung (2 SWS) **COURTESY TRANSLATION:** • Lecture (2 hours per week of the semester) • Exercise (2 hours per week of the semester)

Prerequisites according to examination regulations:	**Recommended prerequisites:**
keine	• Familiarity with learning algorithms for static tabular data • Familiarity with methods for the evaluation of models induced on static data

Media:	**Literature:**

Comments:
Block 1: Literature on streams and time series; is provided in the elearning page of the module
Block 2: New papers are discussed, every time the course is offered

Evolutionary Multi-Objective Optimization

Summer

(in German: Evolutionary Multi-Objective Optimization)

Module-ID: FIN-INF-120469

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
EMO	6	Summer	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	
Responsibility:	Sanaz Mostaghim
Lecturer:	Sanaz Mostaghim
Classes:	• Lecture *Evolutionary Multi-Objective Optimization* • Exercises *Evolutionary Multi-Objective Optimization*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. VC: Computer Science

Intended learning outcomes:
The students...

- have a full understanding of optimization and decision-making algorithms using evolutionary algorithms.
- are able to develop EMO algorithms
- can design optimization algorithms, model optimization problems and perform experiments.

Content:
In our daily life, we are inevitably involved in optimization. How to get to the university in the least time is a simple optimization problem that we encounter every morning. Just looking around ourselves, we can see many examples of optimization problems, even with conflicting objectives and higher complexities. It is natural to want everything to be as good as possible, in other words optimal. The difficulty arises when there are conflicts between different goals and objectives. Indeed, there are many real-world optimization problems with multiple conflicting objectives in science and industry, which are of great complexity. We call them Multi-objective Optimization Problems.
Over the past decade, many new ideas have been investigated and studied to solve such optimization problems as any new development in optimization which can lead to a better solution of a particular problem is of considerable value to science and industry. Among these methods, evolutionary algorithms are shown to be quite successful and have been applied to many applications. This course addresses the basic and advanced topics in the area of evolutionary multi-objective optimization and contains the following content:

- Introduction to single-objective optimization (SO) and multi-objective optimization (MO), classical methods for solving MO, definitions of Pareto-optimality and other theoretical foundations for MO
- Basics of evolutionary algorithms (algorithms, operators, selection mechanisms, coding and representations)
- Evolutionary multi-objective algorithms (NSGA-II, EMO scalarization methods such as MOEA/D)
- Constraint handling in SO and MO, robust optimization in EMO, surrogate methods for expensive function evaluations
- Evaluation mechanisms (Design of experiments, test problems, metrics, visualization)

Workload:
56 h contact time + 124 h self study

Pre-examination requirements:	**Type of examination:**	**Teaching method / lecture hours per week (SWS):**
	Written exam (120 Min) Exercises	• 2 SWS lecture • 2 SWS exercise class

Prerequisites according to examination regulations:	Recommended prerequisites:
none	

Media:	Literature:
	• Deb, Kalyanmoy. Multi-Objective Optimization Using Evolutionary Algorithms, Wiley, 2001. • Coello, Carlos A. Coello, Gary B. Lamont, and David A. Van Veldhuizen. Evolutionary algorithms for solving multi-objective problems. Vol. 5. New York: Springer, 2007. • Miettinen, Kaisa. Nonlinear multiobjective optimization. Vol.12. Springer Science & Business Media, 2012. • Ehrgott, Matthias. Multicriteria optimization. Vol. 491. Springer Science & Business Media, 2005. • Kruse, Rudolf, et al. Computational intelligence: a methodological introduction. Springer, 2016.

Comments:

Introduction to Deep Learning

Summer

(in German: Introduction to Deep Learning)

Module-ID: FIN-INF-120521

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
IDL	6	Summer	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	true
Responsibility:	Sebastian Stober
Lecturer:	Sebastian Stober
Classes:	• Lecture *Introduction to Deep Learning* • Exercise class *Introduction to Deep Learning*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. VC: Computer Science

Intended learning outcomes:
Students ...

- confidently apply DL techniques to develop a solution for a given problem
- follow recent DL publications and critically assess their contributions

- formulate hypotheses and design & conduct DL experiments to validate them
- document progress & design decisions for reproducibility and transparency
- have advanced competencies in scientific research in topics of the module

Content:

- Artificial neural network fundamentals (gradient descent & backpropagation, activation functions)
- Network architectures (Convolutional Neural Networks, Recurrent/Recursive Neural Networks, Auto-Encoders, Transformers)
- Regularization techniques
- Introspection & analysis techniques
- Optimization techniques
- Advanced training strategies (e.g. teacher-student)

Workload:

- 56h contact hours (2 SWS lecture + 2 SWS exercise groups)
- 124h self study (reading assignments (flipped classroom), programming exercises)

Pre-examination requirements:	Type of examination:	Teaching method / lecture hours per week (SWS):
	Exam requirements: participation and active involvement in the course and the exercises (defined in the 1st lecture and published on the course website) Final exam: written (120 minutes) Schein: pass final exam (at least 4.0)	• Lecture (2 SWS) • Exercise (2 SWS)

Prerequisites according to examination regulations:	Recommended prerequisites:
keine	Machine Learning (required)

Media:	Literature:
	Ian Goodfellow, Yoshua Bengio & Aaron Courville: "Deep Learning", MIT Press, 2016.

Comments:

Introduction to Machine Learning Safety

Sommer

(in German: Introduction to Machine Learning Safety)

Module-ID: FIN-INF-120532

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
MLS	6	Sommer	ab 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	
Responsibility:	Prof. Dr. Frank Ortmeier
Lecturer:	Prof. Dr. Frank Ortmeier, Konstantin Kirchheim
Classes:	Vorlesung *Introduction to Machine Learning Safety* Übung *Introduction to Machine Learning Safety*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. VC: Computer Science

Intended learning outcomes:

- Verständnis grundlegender Unterschiede zwischen klassischer Softwareentwicklung und datengetriebener Entwicklung von ML-Systemen sowie der daraus resultierenden Sicherheitsimplikationen.

- Fähigkeit, typische Fehlermodi von ML-Systemen systematisch zu analysieren und deren Ursachen (z. B. Datenverteilung, Modellunsicherheit, Verteilungsverschiebung) zu identifizieren.
- Kompetenz, geeignete Test- und Evaluationsverfahren für ML-Modelle in sicherheitskritischen Kontexten auszuwählen und anzuwenden.
- Einordnung und Bewertung von Unsicherheitsabschätzungen, Anomalieerkennung und Robustheitsmechanismen im Hinblick auf ihre sicherheitstechnische Relevanz.
- Verständnis adversarieller Bedrohungsmodelle sowie grundlegender Verteidigungsstrategien.
- Reflexion regulatorischer, ethischer und gesellschaftlicher Rahmenbedingungen beim Einsatz lernbasierter Systeme.

Content:

- Grundlagen und Sicherheitskontext
- Datenqualität und Modelltestverfahren
- Robustheit und Angriffsmodelle
- Unsicherheit und Anomalieerkennung
- Alignment und gesellschaftliche Aspekte

Workload:

- 20h Übungsteilnahme,
- 20h Vorlesung,
- 40h Vorlesungsvorbereitung,
- 40h Übung,
- 60h Prüfungsvorbereitung

Pre-examination requirements:	**Type of examination:**	**Teaching method / lecture hours per week (SWS):**
Teilnahme an der Übung	Hausarbeit	Übung (2 SWS) Vorlesung (2 SWS)

Prerequisites according to examination regulations:	**Recommended prerequisites:**
keine	Introduction to Deep Learning

Media:	**Literature:**

Comments:

Learning Generative Models

Winter

(in German: Learning Generative Models)

Module-ID: FIN-INF-120522

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
LGM	6	Winter	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	
Responsibility:	Sebastian Stober
Lecturer:	Sebastian Stober
Classes:	• Lecture *Learning Generative Models* • Exercise class *Learning Generative Models*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. VC: Computer Science

Intended learning outcomes:
Students can ..

- confidently apply generative models to develop a solution for a given problem
- follow recent publications on generative models and critically assess their contributions
- formulate hypotheses and design & conduct experiments with generative models to validate them
- document progress & design decisions for reproducibility and transparency

Content:

- Training methods & architectures for generative models, in particular energy-based models (e.g. Restricted Boltzmann Machines, RBMs)
- autoregressive models
- variational learning and Generative Adversarial Nets (GANs)
- flow-based models
- diffusion models

Workload:
56 contact hours + 124h self study

Pre-examination requirements:	Type of examination:	Teaching method / lecture hours per week (SWS):
	• Oral exam (necessary preliminary work for admission to the examination is announced in the first week of the course) • Schein (necessary preliminary work for admission to the examination is announced in the first week of the course)	• 2 SWS lecture • 2 SWS exercise class

Prerequisites according to examination regulations:	Recommended prerequisites:
keine	*Introduction to Deep Learning* or *Deep Learning für Ingenieure* (required)

Media:	Literature:
	Ian Goodfellow, Yoshua Bengio & Aaron Courville: “Deep Learning”, MIT Press, 2016.

Comments:

Neuro-Symbolic Integration

Winter

(in German: Neuro-Symbolic Integration)

Module-ID: FIN-INF-120536

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
NeSy	6	Winter	1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	true
Responsibility:	Martin Glauer
Lecturer:	Martin Glauer
Classes:	• Lectures • Exercise Classes
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INF: Informatik Wahlpflicht (SPO 2027) - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. WIF: Informatik Wahlpflicht (SPO 2027) - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. DE: Informatik Wahlpflicht (SPO 2027) - M.Sc. VC: Computer Science - M.Sc. VC: Computer Science (SPO 2027)

Intended learning outcomes:
Die Absolvent:innen vertiefen die Inhalte der Lehrveranstaltungen Logik und Intelligente Systeme, indem sie lernen, wie diese zu Neuro-Symbolischen Methoden kombiniert werden können. Hierfür werden neuste Forschungsinhalte aus diesem Gebiet vorgestellt und hinsichtlich der Eignung bestimmter Problemstellungen untersucht. Somit lernen Absolvent:innen komplexe Aufgaben aus

der Schnittstelle von Anwendung und Forschung selbstständig zu bewältigen. In den Übungen werden auch offene Aufgaben gestellt, bei denen die eigenen Ergebnisse erklärt und kritisch bewertet und ggf alternative Ansätze vorgeschlagen werden sollen. Die Teilnehmenden können so eigene Ideen einbringen und erlangen detailliertes und kritisches Verständnis der Methoden der neuro-symbolischen Integration.

Content:

- (Fuzzy) Logic
- Neuro-Symbolic Integration nach von Hamelen
- Propositional Program Extraction (Arthur, KBANN)
- Cognitive architectures (CLARION)
- Logic Tensor Networks
- Logical Neural Networks
- Graph Neural Networks
- Ontology-based Training

Workload:
Total: 180 h

- Weekly lecture (2 SWS = 28 h)
  - Follow-up work (20 h)
- Weekly exercise session (2 SWS = 28 h)
  - Completing assignments (84 h)
  - Follow-up work (20 h)

Pre-examination requirements:	**Type of examination:**	**Teaching method / lecture hours per week (SWS):**
• Active participations during the exercise sessions • Voting for exercise tasks	Schriftliche Prüfung/Klausur bzw. elektronische Prüfung (written exam)	Lecture (2 SWS) Exercise (2 SWS)

Prerequisites according to examination regulations:	**Recommended prerequisites:**
keine	Logik/Logic Intelligente Systeme/Intelligent Systems Deep Learning Programming experience (e.g. in Python)

Media:	**Literature:**

- **Books**
  - P. Hitzler and M. K. Sarker (eds.): Neuro-Symbolic Artificial Intelligence, IOS Press, 2022
  - Artur S. d'Avila Garcez, Krysia Broda, Dov M. Gabbay: Neural-symbolic learning systems - foundations and applications. Perspectives in neural computing, Springer 2002 PDF
  - Garcez A, Lamb LC, Gabbay DM. Neural-symbolic cognitive reasoning. Springer; 2009. Cognitive Technologies.
  - Hammer B, Hitzler P, editors. Perspectives of neural-symbolic integration. Springer; 2007.
- **Survey papers**
  - Michael van Bekkum, Maaike de Boer, Frank van Harmelen, André Meyer-Vitali, Annette ten Teije: Modular design patterns for hybrid learning and reasoning systems. Appl. Intell. 51(9): 6528-6546 (2021)
  - Md. Kamruzzaman Sarker, Lu Zhou, Aaron Eberhart, Pascal Hitzler: Neuro-Symbolic Artificial Intelligence: Current Trends. CoRR abs/2105.05330 (2021)
  - Artur d'Avila Garcez, Luís C. Lamb: Neurosymbolic AI: The 3rd Wave. CoRR abs/2012.05876 (2020)
  - Tarek R. Besold, et al.: Neural-Symbolic Learning and Reasoning: A Survey and Interpretation. CoRR abs/1711.03902 (2017)
  - Marra G, Dumancic S, Manhaeve R, et al. From statistical relational to neural symbolic artificial in-telligence: a survey. CoRR abs/2108.11451 (2021)
  - Grady Booch et al.: Thinking Fast and Slow in AI. AAAI 2021: 15042-15046 (2021)
- **Specific approaches**
  - Samy Badreddine, Artur d'Avila Garcez, Luciano Serafini, Michael Spranger: Logic Tensor Networks. Artif. Intell. 303: 103649 (2022)
  - Ryan Riegel et al.: Logical Neural Networks. CoRR abs/2006.13155 (2020)
  - Honghua Dong et al.: Neural Logic Machines. ICLR (Poster) 2019. Also:

Comments:

Recommenders

Summer

Learning Methods and Evaluation Methods for Recommenders

(in German: Recommenders - Master level)

Module-ID: FIN-INF-120525

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
RECSYS-M	9	Summer	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	false
Responsibility:	Myra Spiliopoulou
Lecturer:	Myra Spiliopoulou
Classes:	• Lecture *Recommenders* • Exercise class *Recommenders*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Wirtschaftsinformatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Methoden des Digital Engineering - M.Sc. DE: Methoden der Informatik - M.Sc. VC: Computer Science

Intended learning outcomes:
When successfully completing this module, the students have acquired soft skills and technical expertise, as follows: **SOFT SKILLS:** They

- have learned how to critically discuss and valuate a scientific paper

TECHNICAL EXPERTISE: They

- comprehend the business context of recommenders
- comprehend the different types of recommenders, their advantages and disadvantages from the business perspective and from the mining perspective and are familiar with advanced recommendation methods
- have acquired advanced insights on how to critically evaluate a recommender from the mining perspective and the business perspective
- understand why adaption is necessary in recommenders and comprehend the behaviour of temporal methods for recommenders

and have thus acquired skills they need in order to critically appreciate off-the-shelf or state-of-the-art methods and to design workflows that encompass recommender learning, tuning and evaluation

Content:
The course consists of two blocks:

- Block 1 is on Fundamentals of Recommenders and has mutiple parts: (1.1) recommender goals and workflows, (1.2) simple recommendation methods, (1.3) evaluation mechanisms, (1.4) recommender adaption on a stream
- Block 2 covers advanced topics of recommenders: students read and critically discuss papers in class

Workload:

- 28 Std/hours: Vorlesung/Lecture - in presence (lecture class: 2 hours per week, 28 hours)
- 28 Std/hours: Übung/Exercises - in presence (exercise class: 2 hours per week, 28 hours)
- 214 Stunden: Individual working time on
  - Preparation for lectures and exercise classes
  - Reading and understanding the articles provided
  - Discussion of the articles in class

Pre-examination requirements:	Type of examination:	Teaching method / lecture hours per week (SWS):
A minimum number of points must be achieved during the classes	Schriftliche Prüfung (Klausur)	• Vorlesung (2 SWS) - Lecture class (2 hours-per-week) • Übung (2 SWS) - Exercise class (2 hours-per-week)

Prerequisites according to examination regulations:	Recommended prerequisites:

keine	• Data Mining I • Machine Learning • Data Mining II • Introduction to Deep Learning • Advanced English skills • Reading of scientific papers, as acquired eg in a bachelor seminar

Media:	**Literature:**
	• Literature for Block 1: selected chapters from the 'Recommender Systems Handbook' in the editions: ◦ Recommender Systems Handbook by Francesco Ricci, Lior Rokach and Bracha Shapira (editors), SPRINGER (2015), 2nd edition, https://doi.org/10.1007/978-1-4899-7637-6 ◦ Recommender Systems Handbook by Francesco Ricci, Lior Rokach and Bracha Shapira (editors), SPRINGER (2022), 3rd edition, https://doi.org/10.1007/978-1-0716-2197-4 ◦ Further cited literature, including scientific articles and use cases are cited at the beginning of each unit. • Literature for Block 2: the papers for the discussions in class will be announced during the course

Comments:

Seminar 'Advanced Topics of KMD'

every

(in German: Seminar 'Advanced Topics of KMD')

Module-ID: FIN-INF-120330

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
AdvKMD_Seminar	6	every	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	false
Responsibility:	Myra Spiliopoulou
Lecturer:	Myra Spiliopoulou
Classes:	Seminar *AdvKMD_Seminar*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INF: Schlüssel- und Methodenkompetenzen - M.Sc. INGINF: Informatik - M.Sc. INGINF: Schlüssel- und Methodenkompetenzen - M.Sc. WIF: Wirtschaftsinformatik - M.Sc. WIF: Informatik - M.Sc. WIF: Schlüssel- und Methodenkompetenzen - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DKE: Data Processing for Data Science - M.Sc. DKE: Applied Data Science - M.Sc. DE: Methoden der Informatik - M.Sc. VC: Computer Science

Intended learning outcomes:
When successfully completing this seminar, the students:

- know how to collect literature on a specific topic, and can judge which literature is relevant and which is not
- can compare mining methods, workflows and frameworks that address a specific scientific topic, and can rank them on given criteria
- can formulate such criteria themselves
- can critically discuss the advantages and caveats of a published mining method
- can summarize the papers they collected, their comparisons and critical discussion in an essay
- can present the papers they collected, their comparisons and critical discussion in a pre-specified amount of time and in a way understandable to both an audience that has read the papers and to an audience that has not read, and they can answer questions

Content:
CONTENT: Topics on 'Advanced Knowledge Management and Discovery' for business applications, engineering applications and applications in healthcare; all topics refer to mining algorithms for static or dynamic data **STRUCTURE:** Each student receives a topic as assignment. The assignment encompasses:

- one or more 'seed' papers in the topic's area
- a series of questions to be answered, and which concern state of the art (SOTA) methods in the topic area, challenges addressed by these methods, evaluation criteria on the performance of these methods, evaluation procedures and datasets

The student must:
1. collect additional literature from the topic area in a transparent manner
2. compare the scientific advances in the collected literature in order to answer the scientific questions
3. critically discuss and rank the methods compared in the previous step
4. present the collected literature, the comparisons and the results in class
5. write an essay on them

Workload:

- 28 hours Seminar+Consultations in class
- 124 hours self-study work on scientific papers

Pre-examination requirements:	Type of examination:	Teaching method / lecture hours per week (SWS):
	Referat	Seminar (2 SWS)

Prerequisites according to examination regulations:	Recommended prerequisites:

none	• Familiarity with advanced mining methods • Familiarity with procedures for the evaluation of models and the comparison of models • Underpinnings of scientific writing (e.g. through a bachelor seminar or a bachelor thesis)

Media:	**Literature:**
	The literature of the seminar covers several topics. For each topic, it consists of the papers assigned to each student and the paper that the student collects on that topic. The topics change in each semester.

Comments:
The seminar contains several topics. The mapping of the module (see field 'Verwendbarkeit') depends on the topic assigned to a specific student.

Seminar on Advanced Topics of Predictive Maintenance

every

(in German: Seminar on Advanced Topics of Predictive Maintenance)

Module-ID: FIN-INF-120489

Abbreviation	**Credit Points**	**Semester**	**Term**	**Duration**	**Language**	**Level**
PredMa_Masterseminar	6	every	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	true
Responsibility:	Prof. Dr.-Ing. Benjamin Noack, Prof. Dr. Myra Spiliopoulou
Lecturer:	Prof. Dr.-Ing. Benjamin Noack, Prof. Dr. Myra Spiliopoulou
Classes:	• Seminar *Advanced Topics of Predictive Maintenance*

Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INF: Schlüssel- und Methodenkompetenzen - M.Sc. INF: Informatik Wahlpflicht (SPO 2027) - M.Sc. INF: Schlüssel- und Methodenkompetenz (SPO 2027) - M.Sc. INGINF: Informatik - M.Sc. INGINF: Schlüssel- und Methodenkompetenzen - M.Sc. WIF: Wirtschaftsinformatik - M.Sc. WIF: Informatik - M.Sc. WIF: Schlüssel- und Methodenkompetenzen - M.Sc. WIF: Informatik Wahlpflicht (SPO 2027) - M.Sc. WIF: Wirtschaftsinformatik (SPO 2027) - M.Sc. WIF: Schlüssel- und Methodenkompetenz (SPO 2027) - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DKE: Applied Data Science - M.Sc. DE: Methoden des Digital Engineering - M.Sc. DE: Methoden der Informatik - M.Sc. DE: Digital Engineering (SPO 2027) - M.Sc. DE: Schlüssel- und Methodenkompetenz (SPO 2027) - M.Sc. VC: Computer Science - M.Sc. VC: Computer Science (SPO 2027)

Intended learning outcomes:
Students who complete the course ...

- read scientific articles given to them on introductory topics of predictive maintenance
- discuss these articles and reflect on them
- compare the methods that appear in these articles and discuss the pros and contra of each method in comparison to other methods
- summarize article contents on predictive maintenance in a report and present them
- formulate questions on these articles and answer questions formulated by other seminar participants

Content:
In this seminar, the participants will learn about

- challenges and methods for data acquisition in industrial processes
- data analysis tools in predictive maintenance
- process modeling, fault detection, and state prediction for industrial applications

Workload:
28h in presence (consultation meetings, presentations) + 156 h self study

Pre-examination requirements:	Type of examination:	Teaching method / lecture hours per week (SWS):

	Referat	Seminar (2 SWS)

Prerequisites according to examination regulations:	**Recommended prerequisites:**
none	• Signal and information processing • Learning algorithms • Underpinnings of engineering sciences and/or business informatics (some topics only) • Principles of scientific writing

Media:	**Literature:**
	Literature depends on topic assignment and is given to each student together with the assignment

Comments:

Swarm Intelligence

Winter

(in German: Swarm Intelligence)

Module-ID: FIN-INF-102419

Abbreviation	Credit Points	Semester	Term	Duration	Language	Level
SI	6	Winter	starting at 1.	1 Semester	english	Master

Link:	LSF
Limited accessability:	true
Responsibility:	Sanaz Mostaghim
Lecturer:	Sanaz Mostaghim
Classes:	• Vorlesung *Swarm Intelligence* • Übung *Swarm Intelligence*
Applicability in curriculum:	- M.Sc. INF: Informatik - M.Sc. INGINF: Informatik - M.Sc. WIF: Informatik - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DE: Fachliche Spezialisierung - M.Sc. VC: Computer Science

Intended learning outcomes:
The students will get an understanding about Swarm Intelligence and its definitions. They will get the ability to develop swarm intelligence algorithms such as swarm aggregation, swarm movements, tracking, tracing and optimization. In addition, they learn the foundations in collective decision-making and their applications. The students can implement, analyse and evaluate swarm algorithms on several applications.

Content:
This course provides in-depth knowledge about swarm intelligence in technical systems. In swarm intelligence, we deal with a group of simple and usually homogenous individuals with simple rules. Usually, swarms can achieve a complex and intelligent behaviour using local interactions between its members. This collective property can be used in technical systems. One advanced application of swarm intelligence is in swarm robotics, in which simple small robots can collectively learn to achieve some predefined complex tasks. During this course, the algorithms of swarm intelligence are presented, analysed and compared. The following topics will be covered: Part 1: Fundamentals of swarm intelligence

- Swarm stability and stability analysis
- Swarm aggregation
- Swarm in known environments
- Swarm in unknown environments: Particle Swarm Optimization
- Dynamic Optimization
- Multi-Objective Particle Swarm Optimization

Part 2: Swarm and multiagent systems
- Division of labour and task allocation
- Swarm clustering and sorting
- Ant systems and optimization

Part 3: Applications
- Swarm localization and display
- Swarm robotics

Workload:
Präsenzzeit: 2 SWS Vorlesung 2 SWS Übungen Selbstständige Arbeit: Bearbeiten von Übungs- und Programmieraufgaben 180 h = 56 h Präsenzzeit + 124 h selbstständige Arbeit

Pre-examination requirements:	**Type of examination:**	**Teaching method / lecture hours per week (SWS):**
All students that participate can take the exam.	Written Exam (120 min)	Vorlesung (2 SWS) Übung (2 SWS)

Prerequisites according to examination regulations:	**Recommended prerequisites:**
keine	Informatik (Algorithmen und Datenstrukturen, Maschinelles Lernen)

Media:	**Literature:**

	Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm In-telligence: From Natural to Artificial Systems, Oxford University Press, 1999Andries Engelbrecht, Fundamentals of Computational Swarm Intelligence, Wiley 2006 James Kennedy and Russel Eberhart, Swarm Intelligence, Morgan Kaufmann, 2001 Zbigniew Michalewicz and David Fogel, How to solve it: Modern Heuristics, Springer, 2001 Veysel Gazi, Stability Analysis of Swarms, The Ohio State University, 2002 Marco Dorigo and Thomas Stützle, Ant Colony Optimization, The MIT Press, 2004 C. Solnon: Ant Colony Optimization and Constraint Program-ming. Wiley 2010 Gerhard Weiss, Multiagent Systems: A modern approach to distributed artificial systems, The MIT Press, 2000 Christian Müller-Schloer, Hartmut Schmeck and Theo Ungerer, Organic Computing – A Paradigm Shift for Complex Systems, Springer, 2011

Comments:

Enrollment is limited to a maximum number of participants. If necessary, students will be selected based on a statement of purpose submitted at the beginning of the semester.

Wissenschaftliches Individualprojekt

jedes

(engl. Individual Scientific Project)

Modulnummer: FIN-INF-120301

Kürzel	CP	Semester	Fachsem.	Dauer	Sprache	Niveau
WIP	6	jedes	ab 1.	1 Semester	deutsch	Master

Link zum LSF:	LSF
Zugang beschränkt:	
Verantwortung:	Studiendekan:in der FIN
Dozent:in:	Alle Dozenten der FIN
Lehrveranstaltungen:	keine

Verwendbarkeit:	- M.Sc. INF: Informatik - M.Sc. INF: Schlüssel- und Methodenkompetenz (SPO 2027) - M.Sc. INF: Projekte (SPO 2027) - M.Sc. INGINF: Informatik - M.Sc. INGINF: Ingenieurinformatik - M.Sc. WIF: Wirtschaftsinformatik - M.Sc. WIF: Informatik - M.Sc. WIF: Schlüssel- und Methodenkompetenz (SPO 2027) - M.Sc. WIF: Projekte (SPO 2027) - M.Sc. DKE: Learning Methods and Models for Data Science - M.Sc. DKE: Data Processing for Data Science - M.Sc. DKE: Applied Data Science - M.Sc. DKE: Projects (SPO 2027) - M.Sc. DE: Human Factors - M.Sc. DE: Methoden des Digital Engineering - M.Sc. DE: Methoden der Informatik - M.Sc. DE: Fachliche Spezialisierung - M.Sc. DE: Schlüssel- und Methodenkompetenz (SPO 2027) - M.Sc. DE: Projekte (SPO 2027) - M.Sc. VC: Visual Computing - M.Sc. VC: Computer Science - M.Sc. VC: Schlüssel- und Methodenkompetenz (SPO 2027) - M.Sc. VC: Projekte (SPO 2027)

Angestrebte Lernergebnisse:
Die Studierenden ...

- arbeiten selbstständig an einer wissenschaftlichen Fragestellung
- arbeiten sich selbstständig in ein wissenschaftliches Spezialgebiet ein
- erarbeiten vertiefte Kenntnisse auf einem wissenschaftlichen Spezialgebiet
- präsentieren und interpretieren ihre Ergebnisse in mündlicher und/oder schriftlicher Form
- können ihren Erfolg und die Bedeutung ihrer Ergebnisse einschätzen
- beschreiben die Auswirkungen ihrer Entscheidungen auf den Verlauf und die Ergebnisse des Projektes

Inhalt:
Die Studierenden bearbeiten in selbstständiger Arbeit eine individuell vereinbarte, wissenschaftliche Fragestellung unter Anleitung eines Hochschullehrers. Im Projekt entwickeln die Studierenden eine eigenständige Informatik-Lösung. Dadurch erwerben sie ein detailliertes und kritisches Verständnis in einem Spezialbereich der Informatik. Dieses Modul wird von unterschiedlichen Hochschullehrern implementiert. Die fachlichen Inhalte sind daher angebotsspezifisch.

Arbeitsaufwand:
180h selbstständige Arbeit

Prüfungsvorleistungen:	Studien-/Prüfungsleistungen:	Lehrform / SWS:
	Wissenschaftliches Projekt	Angeleitetes wissenschaftliches Individualprojekt

Voraussetzungen nach Prüfungsordnung:	Empfohlene Voraussetzungen:
keine	

Medienformen:	Literatur:

Hinweise:
Projekte außerhalb der FIN müssen von Studiengangsleiter abgesegnet werden.