Master of Science (M.Sc.)

„Mannheim Master in Data Science“

University of Mannheim

– Module catalog –

Appendix

Academic Year

HWS 23/24

Die folgenden Veranstaltungen wurden nach Veröffentlichung des Modulkatalogs dem Kursprogramm hinzugefügt.

Overview

B. Fundamentals

Module No.	Name of Module	Offered	Language	ECTS
DS 100	Statistics for Data Scientists	HWS	E	8

C. Data Managenet

Module No.	Name of Module	Offered	Language	ECTS
CS 647	Image Processing	HWS	E	6
CS 646	Higher Level Computer Vision	HWS	E	6

D. Data Analytics Methods

Module No.	Name of Module	Offered	Language	ECTS
TBA	Reinforcement Learning - Coding	Irreg.	E	5

E. Responsible Data Science

Module No.	Name of Module	Offered	Language	ECTS
DS 203	Responsible AI: Conceptual Foundations, Methods and Applications	HWS	E	6

Detailed Descriptions

DS 100	**Statistics for Data Scientists**
Form of module	Lecture and Tutorial
Type of module	Foundations of Data Science
Level	Master
ECTS	8 (240 hours)
Workload	Hours per semester present: 56 h (4 SWS)
	Self-study: 152 h per semester • 91 h: pre and post lecture/tutorial studying and revision • 42 h: studying for and taking weekly online tests • 40 h: examination preparation • 41 h: preparation and presentation of weekly exercises
Prerequisites	A sound understanding of the linear regression model (OLS) is required. Knowledge in linear algebra and calculus is useful.
Aim of module	The course provides an introduction to causal inference, linear models, and maximum likelihood estimation. The course will cover the following topics: • Causal Inference • Hypotheses testing • Linear Regression · Selected GLM, e.g., binary choice models, models for ordinal data, models multinomial data, models for count data
Learning outcomes and qualification goals	Expertise (MK1, MK3): Understand how to appropriately translate research question into statistical models, be able to apply statistical models appropriate for non-linear problems and learn how to present and interpret estimation results in a substantive meaningful way.
	Methodological competence (MK1, MK3): Estimate regression parameters using the maximum likelihood principle; Perform hypothesis tests for regression models using the maximum likelihood principle; Be able to identify violations

	of the respective regression assumptions of the discussed GLMs; Be able to identify limitations of non-linear regression models.
	Personal competence (MF1, MF2, MF3, MKO1, MKO2): The course supports students to develop competences with regard to choosing the appropriate statistical method(s) to answer respective research questions and how to present and communicate statistical results.
Media	Lecture slides available online, exercises available online
Literature	• Cameron, C.A. and P.K. Trivedi. 1998. Regression Analysis of Count Data. Cambridge: Cambridge University Press. • Greene, W.H. (2008). Econometric Analysis. 6th ed. Upper Saddle River: Prentice Hall. • Long, J.S. (1997). Regression Models for Categorical and Limited Dependent Variables. Thousand Oaks: Sage. • Verbeek, M. 2017. A Guide to Modern Econometrics. 5th ed. Chichester: Wiley. • Wooldridge, J.M. 2002. Econometric Analysis of Cross Section and Panel Data. Cambridge, MA: MIT Press. • Imbens, Guido W., and Donald B. Rubin. Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction. Cambridge: Cambridge University Press, 2015. • Angrist, Joshua D., and Jorn-Steffen Pischke. Mostly Harmless Econometrics: An Empiricist's Companion. Princeton: Princeton University Press, 2009.
Methods	Lecture elements, weekly online tests, literature studies
Form of assessment	Written examination
Admission requirements for assessment	Oral participation, homework, presentations, compulsory attendance
Duration of assessment	90 Minutes
Language	English
Offering	Fall semester
Lecturer	Lecturer of the School of Social Sciences, I.e chair of Social Data Science
Person in charge	Lecturer of the School of Social Sciences, I.e. Chair of social Data Science

Duration of module	1 semester
Further modules	
Range of application	MMDS
Semester	1st semester

CS 647	**Image Processing**
Form of module	Lecture with Exercise
Type of module	Specializaton Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4SWS)
	Self-study: 98h • 70h lecture/exercises • 28h exam preparation
Prerequisites	Basis skills in linear algebra, basis knowledge in python
Aim of module	• Introduction to Imaging (human visual system, optics, sensors) • Noise and basic operations (convolution, correlations, gradients) • Energy minimization • Variational Methods • Feature extraction • Classification • Segmentation • Image Sequences and Motion (Optical Flow) • Stereo Vision
Learning outcomes and qualification goals	Expertise: The students have a detailed understanding of image and video processing techniques. They can evaluate given image processing algorithms. (MK1, MK2, MF1, MF3)
	Methodological competence: Students understand the technical basis of image processing algorithms; they can explain the discussed methods and implement them. (MF1, MF2, MF3)
	Personal competence: Understanding complex Image Processing problems; thorough judgment in the design and use of methods; can work efficiently in a team. (MK01, MK02)

Media	Exercise sheets and lecture slides available online.
Literature	• R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2010. ISBN: 978-1-84882-934-3. (Online available: http://szeliski.org/Book/) • D. Forsyth, J. Ponce: Computer Vision: A Modern Approach, Prentice Hall, 2nd edition, 2012. ISBN: 978-0136085928 (Online available: http://cmuems.com/excap/readings/forsyth-ponce-computer-vision-a-modern-approach.pdf)
Methods	Lecture, weekly exercise, book studies, implementation of algorithms, visualization of results
Form of assessment	Written or oral examination (TBA)
Admission requirements for assessment	-
Duration of assessment	90 minutes (written) or 20 minutes (oral)
Language	English
Offering	Fall Semester
Lecturer	Professor Dr.-Ing. Margret Keuper
Person in charge	Professor Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	Higher Level Computer Vision
Range of application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

CS 646	**Higher Level Computer Vision**
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4SWS)
	Self-study: 98h • 70h lecture/exercises • 28h exam preparation
Prerequisites	Basis skills in linear algebra, basis knowledge in python and pytorch
Aim of module	• Point Features and point matching • Object Identification • Deep Learning for Computer Vision • Object Detection • Image Segmentation • Optical Flow • Video and Motion Segmentation
Learning outcomes and qualification goals	Expertise: The students have a detailed understanding of Computer Vision techniques. They can evaluate given Computer Vision algorithms. (MK1, MK2, MF1, MF3)
	Methodological competence: Students understand the technical basis of Computer Vision algorithms; they can explain the discussed methods and implement them. (MF1, MF2, MF3)
	Personal competence: Understanding complex Computer Vision problems; thorough judgment in the design and use of methods; can work efficiently in a team. (MK01, MK02)
Media	Exercise sheets and lecture slides available online.

Literature	• Goodfellow et al..: Deep Learning, MIT Press, 2016. https://www.deeplearningbook.org/ • R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2010. ISBN: 978-1-84882-934-3. (Online available: http://szeliski.org/Book/ • D. Forsyth, J. Ponce: Computer Vision: A Modern Approach, Prentice Hall, 2nd edition, 2012. ISBN: 978-0136085928 (Online available: http://cmuems.com/excap/readings/forsyth-ponce-computer-vision-a-modern-approach.pdf • R. Hartley, A. Zisserman: Multiple View Geometry in Computer Vision, Cambridge University Press, 2nd edition, 2004.
Methods	Lecture, weekly exercise, book studies, implementation of algorithms, visualization of results
Form of assessment	Written or oral examination (TBA)
Admission requirements for assessment	-
Duration of assessment	90 minutes (written) or 20 minutes (oral)
Language	English
Offering	Fall semester
Lecturer	Professor Dr.-Ing. Margret Keuper
Person in charge	Professor Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	Image Processing
Range of application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

TBA	**Reinforcement Learning - Coding**
Form of module	Lectures with exercises
Type of module	Mathematics C
Level	Master
ECTS	5
Workload	28 hours lectures 122 hours self-studies
Prerequisites	Reinforcement Learning
Aim of module	Implementation of standard algorithms in reinforcement learning • Bandit algorithms (UCB) • TD algorithms (Q-learning, TD) • Policy gradient algorithms (SAC, PPO)
Learning outcomes and qualification goals	MK1, M02, M03
	MF1, MF3
	(cf, “Erläuterungen zu den Abkürzungen”)
Media	Blackboard, Slides
Literature	Original articles
Methods	Lectures, programmig tasks
Form of assessment	written exam
Admission requirements for assessment	-
Duration of assessment	90 min
Language	English
Offering	irregular
Lecturer	Prof. Dr. Leif Döring
Person in charge	Prof. Dr. Leif Döring
Duration of module	1 semester

Further modules	-
Range of application	M.Sc. Wirtschaftsmathematik, B.Sc. Wirtschaftsmathematik, M.Sc. Mathematik, M.Sc. Mannheim Master in Data Science, M.Sc. Wirtschaftsinformatik
Semester	1st, 2nd, 3rd

DS 203	**Responsible AI: Conceptual Foundations, Methods and Applications**
Form of module	Lecture with Essay
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester in presence: 28 (2 SWS) Self-study: 56 h lectures; 20 h essay / preparation oral exam
Prerequisites	Basic knowledge about AI systems (knowledge-based systems, machine learning, deep neural networks)
Aim of module	Conceptual foundations: - understanding of important concepts in human-AI interaction and AI ethics (such as trust, autonomy, responsibility) Methods: - e.g., narrative interviews, group discussions, design research methods (prototyping, design thinking, techno-mimesis), (digital) ethnography, participatory action research Applications: - AI in medicine and healthcare - Social robotics - Generative AI - other use cases / real-world AI applications
Learning outcomes and qualification goals	Expertise: Students gain insights and understanding of important concepts in human-AI interaction and AI ethics. They learn modes of transdisciplinary thinking and theorizing. Along sector-specific use cases they learn about ethical, legal and social aspects and challenges of real-world AI application, e.g. for healthcare.
	Methodological competence: Students learn elements of mixed-methods study design for human-AI interaction research
	Personal competence: Students learn to critically assess conceptual, ethical, legal and social aspects of human-AI interaction. They gain skills in transdisciplinary research and theory-building and learn to transfer these insights to real-world human-AI interaction scenarios.
Media	Slides are available online
Literature	- Voeneky, S., P. Kellmeyer, O. Mueller, and W. Burgard, ed. 2022. The Cambridge Handbook of Responsible Artificial Intelligence:

	Interdisciplinary Perspectives. Cambridge Law Handbooks. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781009207898 (open source) - Coeckelbergh, Mark. AI ethics. (2020). The MIT Press. https://www.gbv.de/dms/bowker/toc/9780262538190.pdf - Heilinger, J.-C. (2022). The Ethics of AI Ethics. A Constructive Critique. Philosophy & Technology, 35(3), 61. https://doi.org/10.1007/s13347-022-00557-9 - McLennan, S., Fiske, A., Tigard, D., Müller, R., Haddadin, S., & Buyx, A. (2022). Embedded ethics: A proposal for integrating ethics into the development of medical AI. BMC Medical Ethics, 23(1), 6. https://doi.org/10.1186/s12910-022-00746-3 - Schmitt, L. (2021). Mapping global AI governance: A nascent regime in a fragmented landscape. AI and Ethics. https://doi.org/10.1007/s43681-021-00083-y
Methods	Interactive lecture
Form of assessment	Essay
Admission requirements for assessment	--
Duration of assessment	Essays need to be handed in by December 8th
Language	English
Offering	Fall semester
Lecturer	JProf. Dr. Philipp Kellmeyer
Person in charge	JProf. Dr. Philipp Kellmeyer
Duration of module	1 Semester
Further modules	Follow-up (block) seminar planned for summer semester 2024
Range of application	Msc Business Informatics, Msc Data Science, Lehramt Informatik
Semester	All semesters possible