# Master of Science (M.Sc.)

# „Business Informatics“

University of Mannheim

– Module catalog –

for students starting in spring 2018 or later

**Appendix**

Academic Year

HWS 2023/ FSS 2024

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

## 1. Overview

## C. Specialization Courses

| Module No. | Name of Module | Offered | Language | ECTS |
|---|---|---|---|---|
| DS 203 | Responsible AI: Conceptual Foundations, Methods and Applications | HWS | E | 6 |
| MAC 570 | Reinforcement Learning - Coding | HWS | E | 5 |
| CS 647 | Image Processing | HWS/FSS | E | 6 |
| CS 646 | Higher Level Computer Vision | HWS | E | 6 |
| CS 668 | Generative Computer Vision Models | FSS | E | 6 |
| IS 515* | Process Management and Analytics* | HWS | E | 6 |
| IS 628* | Advances in Public Blockchains* | HWS | E | 6 |
| IE 698 | Foundations and Applications of Digital Health Technologies | FSS | E | 3 |
| IE 699 | Co-creating digital health applications with design methodology | FSS | E | 6 |

* For a detailed description please use the module catalogue of the „Mannheim Master in Management": https://www.bwl.uni-mannheim.de/media/Fakultaeten/bwl/Dokumente/Studium/MMM/Fruehere_Modulkataloge/MMM_Modulkatalog_ab_2022_de.pdf

## D. Projects and Seminars

| Module No. | Name of Module | Offered | Language | ECTS |
|---|---|---|---|---|
| CS 717 | Master Seminar on Computer Vision | FSS | E | 4 |

## 2. Detailed descriptions

## C. Specialization Courses

| **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)<br>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:<br>- understanding of important concepts in human-AI interaction and AI ethics (such as trust, autonomy, responsibility)<br>Methods:<br>- e.g., narrative interviews, group discussions, design research methods (prototyping, design thinking, techno-mimesis), (digital) ethnography, participatory action research<br>Applications:<br>- AI in medicine and healthcare<br>- Social robotics<br>- Generative AI<br>- 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 |

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| | 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)<br>- Coeckelbergh, Mark. AI ethics. (2020). The MIT Press. https://www.gbv.de/dms/bowker/toc/9780262538190.pdf<br>- 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<br>- 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<br>- 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 |

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| Range of application | Msc Business Informatics, Msc Data Science, Lehramt Informatik |
| Semester | All semesters possible |

| **MAC 570** | Reinforcement Learning - Coding |
|---|---|
| Form of module | Lectures with exercises |
| Type of module | Mathematics C |
| Level | Master |
| ECTS | 5 |
| Workload | 28 hours lectures<br>122 hours self-studies |
| Prerequisites | Reinforcement Learning |
| Aim of module | Implementation of standard algorithms in reinforcement learning<br>• Bandit algorithms (UCB)<br>• TD algorithms (Q-learning, TD)<br>• 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 |

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| 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 |

| **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<br>• 70h lecture/exercises<br>• 28h exam preparation |
| Prerequisites | Basis skills in linear algebra, basis knowledge in python |
| Aim of module | • Introduction to Imaging (human visual system, optics, sensors)<br>• Noise and basic operations (convolution, correlations, gradients)<br>• Energy minimization<br>• Variational Methods<br>• Feature extraction<br>• Classification<br>• Segmentation<br>• Image Sequences and Motion (Optical Flow)<br>• 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.<br>(MK1, MK2, MF1, MF3) |
| | Methodological competence: Students understand the technical basis of image processing algorithms; they can explain the discussed methods and implement them.<br>(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.<br>(MK01, MK02) |

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| 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/)<br>• 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/ Spring 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<br>• 70h lecture/exercises<br>• 28h exam preparation |
| Prerequisites | Basis skills in linear algebra, basis knowledge in python and pytorch |
| Aim of module | • Point Features and point matching<br>• Object Identification<br>• Deep Learning for Computer Vision<br>• Object Detection<br>• Image Segmentation<br>• Optical Flow<br>• 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.<br>(MK1, MK2, MF1, MF3) |
| | Methodological competence: Students understand the technical basis of Computer Vision algorithms; they can explain the discussed methods and implement them.<br>(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.<br>(MK01, MK02) |
| Media | Exercise sheets and lecture slides available online. |

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| Literature | • Goodfellow et al..: Deep Learning, MIT Press, 2016. https://www.deeplearningbook.org/<br>• R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2010. ISBN: 978-1-84882-934-3. (Online available: http://szeliski.org/Book/<br>• 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<br>• 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 |

| **CS 668** | **Generative Computer Vision Models** |
|---|---|
| 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<br>• 70h lecture/exercises<br>• 28h exam preparation |
| Prerequisites | Basis skills in linear algebra, basis knowledge in python/pytorch |
| Aim of module | • Introduction to Clustering and Unsupervised Learning<br>• Introduction to Generative Models<br>• Autoregressive Models for Image Generation<br>• (Normalizing) Flow<br>• Latent Variable Models<br>• Latent Space Visualizations<br>• Generative Adversarial Models<br>• Diffusion Models<br>• Multi-Modal Conditioning |
| Learning outcomes and qualification goals | Expertise: The students have a detailed understanding of image generation techniques, latent variable models, and their evaluations.<br>(MK1, MK2, MF1, MF3) |
| | Methodological competence: Students understand the technical basis of generative models; they can explain the discussed methods and implement them.<br>(MF1, MF2, MF3) |
| | Personal competence: Understanding image generative models, their working principles and training procedures; thorough judgment in the design and use of methods; Students can work efficiently in a team.<br>(MK01, MK02) |

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| Media | Exercise sheets and lecture slides available online. |
| Literature | • Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT press book, 2016. |
| 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 | Spring 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 |

| **IE 698** | **Foundations and Applications of Digital Health Technologies** |
|---|---|
| Form of module | Lecture with Excercise |
| Type of module | Specialization Course |
| Level | Master |
| ECTS | 3 |
| Workload | Hours per semester in presence: 28 h per semester<br>Self-study: 56 h per semester |
| Prerequisites | Necessary: Basic knowledge about AI systems (knowledge-based systems, machine learning, deep neural networks)<br>Optional:<br>- Participation of Lecture “Responsible AI” Winter Term 2023/24<br>- Basic knowledge about digital health systems |
| Aim of module | Conceptual foundations:<br>- Understanding of important concepts in digital health (eHealth, mHealth, telehealth, digital phenotyping, digital twins, and other concepts)<br>Methods:<br>- e.g., interviewing, group discussions, design research methods (prototyping, design thinking, co-design), (digital) ethnography<br>Applications:<br>- AI in digital health apps in medicine and healthcare<br>- AI-based robots<br>- AI-based VR systems |
| Learning outcomes and qualification goals | Knowledge (MK1): Students gain insights and understanding of important concepts in digital health. They learn modes of transdisciplinary thinking and theorizing on digital health. |
| | Capabilities (MF1 and MF2): Students learn elements of mixed-methods study design for digital health research and co-design methodology and learn to assess scientific publications in this domain critically. |
| | Competencies (MKO1): Students learn to critically assess the conceptual, technical, ethical, legal, and social aspects of digital health applications. |
| Media | Slides and supporting media will be available online. |
| Literature | - Fagherazzi, G. Deep Digital Phenotyping and Digital Twins for Precision Health: Time to Dig Deeper. Journal of Medical Internet Research 22, e16770 (2020). https://www.jmir.org/2020/3/e16770/ |

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| | - Hahn, H. & Schreiber, A. E-Health. in Digital Transformation (ed. Neugebauer, R.) 311–334 (Springer Berlin Heidelberg, 2019). https://doi.org/10.1007/978-3-662-58134-6_19<br>- Budd, J. et al. Digital technologies in the public-health response to COVID-19. Nat Med 26, 1183–1192 (2020). https://www.nature.com/articles/s41591-020-1011-4<br>- 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) |
| Methods | Interactive lecture |
| Form of assessment | Written exam |
| Admission requirements for assessment | - |
| Duration of assessment | 45 min |
| Language | English |
| Offering | Spring semester |
| Lecturer | Jun.-Prof. Dr. Philipp Kellmeyer |
| Person in charge | Jun.Prof. Dr. Philipp Kellmeyer |
| Duration of module | 1 Semester |
| Further modules | Lecture on Responsible AI, Fall 2024 |
| Range of application | Msc Business Informatics, Msc Data Science, Lehramt Informatik |
| Semester | All semesters possible |

| IE 699 | Co-creating digital health applications with design methodology |
|---|---|
| Form of module | Excercise |
| Type of module | Specialization Course |
| Level | Master |
| ECTS | 6 |
| Workload | Hours per semester in presence: 56 h<br>Self-study: 112 h |
| Prerequisites | Necessary: Basic knowledge about AI systems (knowledge-based systems, machine learning, deep neural networks)<br>Optional:<br>- Participation of Lecture “Responsible AI” Winter Term 2023/24<br>- Basic knowledge about digital health systems |
| Aim of module | Conceptual foundations: Understanding of important concepts in digital health (eHealth, mHealth, telehealth, digital phenotyping, digital twins, and other concepts)<br>Methods: Interviewing, group discussions, design research methods (prototyping, design thinking, co-design), (digital) ethnography<br>Applications: By-design approaches to developing digital health apps and other solutions. |
| Learning outcomes and qualification goals | Knowledge (MK1): Along with digital health use cases, they learn basic by-design principles for developing digital health applications. |
| | Capabilities (MF1, MF2, MF3): Students learn elements of mixed-methods study design for digital health research and co-design methodology via design fictions and mockups developed in groups in the exercise |
| | Competencies (MKO1): Students learn to apply their knowledge and capabilities regarding by-design approaches to solve specific problems in a team context. |
| Media | Slides and supporting media will be available online. |
| Literature | - Fagherazzi, G. Deep Digital Phenotyping and Digital Twins for Precision Health: Time to Dig Deeper. Journal of Medical Internet Research 22, e16770 (2020). https://www.jmir.org/2020/3/e16770/<br>- Hahn, H. & Schreiber, A. E-Health. in Digital Transformation (ed. Neugebauer, R.) 311–334 (Springer Berlin Heidelberg, 2019). https://doi.org/10.1007/978-3-662-58134-6_19<br>- Budd, J. et al. Digital technologies in the public-health response to COVID-19. Nat Med 26, 1183–1192 (2020). https://www.nature.com/articles/s41591-020-1011-4 |

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| | - 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) |
| Methods | Excercise |
| Form of assessment | Presentation in course |
| Admission requirements for assessment | - |
| Duration of assessment | 20 min (15 min. Presentation, 5 min Q&A) |
| Language | English |
| Offering | Spring semester |
| Lecturer | Jun.-Prof. Dr. Philipp Kellmeyer |
| Person in charge | Jun.Prof. Dr. Philipp Kellmeyer |
| Duration of module | 1 Semester |
| Further modules | Lecture on Responsible AI, Fall 2024 |
| Range of application | Msc Business Informatics, Msc Data Science, Lehramt Informatik |
| Semester | All semesters possible |

## D. Projects and Seminars

| **CS 717** | **Master Seminar on Computer Vision** |
|---|---|
| Form of module | Seminar |
| Type of module | Seminar |
| Level | Master |
| ECTS | 4 |
| Workload | 120 h per semester |

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| Prerequisites | Higher Level Computer Vision or Image Processing |
| Aim of module | The student prepares a scientific paper and gives a presentation on a current research topic based on published research. State-of-the-art topics are proposed by the professors. The paper and the presentation are prepared under the guidance of a professor or a research staff member. Active participation in the seminar discussions is expected. |
| Learning outcomes and qualification goals | Expertise:<br>The student gains a deep understanding of the research topic. He/she is able to describe/summarize the topic in detail in his/her own words. He/she reflects on the topic and judges the contribution of the research papers. |
| | Methodological competence:<br>The student is able to write a well-structured scientific paper and to present his/her results. He/she is also aware of the need to avoid plagiarism. The key qualification Scientific Research is highly recommended as a prerequisite for the seminar. |
| | Personal qualification:<br>The student has learned how to write a well-structured, concise paper and give a presentation. This is part of the preparation to write and present a Master's Thesis. |
| Media | Scientific papers and books |
| Literature | Depending on the topic of the seminar |
| Methods | Do scientific reading independently under the guidance of a professor or a research staff member. Active discussions in a group of peers. |
| Form of assessment | 30% Presentation (takes place after one month)<br>70% Seminar Report (has to be submitted after three month) |
| Admission requirements for assessment | |
| Duration of assessment | N/A |

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|---|---|
| Language | English |
| Offering | FSS |
| Lecturer | Margret Keuper |
| Person in charge | Margret Keuper |
| Duration of module | 1 Semester |
| Further modules | |
| Range of application | M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science |
| Semester | 3rd Semester |