Degree Program Documentation Elite Master's Program AI in Biomedicine

Part A

TUM School of Computation, Information and Technology
Technical University of Munich

General Information:

- Administrative responsibility: School of Computation, Information and Technology
  Professional Profile Data Science
  and Artificial Intelligence
- Name of degree program: AI in Biomedicine
- Degree: Master of Science (M.Sc.)
- Standard duration of study and credits:
  4 semester of enrollment and 120 credit points (CP),
  + optional 30 CP for Research Excellence Certificate

- Form of study: full time
- Admission: Aptitude assessment (EV – Master's)
- Start: Winter semester (WiSe) 2026/2027
- Language of Instruction: English
- Main Location: Garching
- Additional information: curriculum will be jointly hosted at the TUM School of CIT and Friedrich-Alexander-Universität Erlangen-Nürnberg Department of Artificial Intelligence in Biomedical Engineering (AIBE)
  Elite Master's Program funded by the Elite Network of Bavaria
- Tuition fees for students from non-EEA countries:
  Tuition fee category II (6.000 € per semester)
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1 Degree Program Objectives

1.1 Purpose

Demographic change is leading to a growing global demand for high-quality and cost-effective healthcare. Aging populations, the rise of chronic diseases, and increasing healthcare costs are placing significant pressure on medical systems worldwide. These challenges call for innovative solutions that can improve efficiency, enhance diagnostic and therapeutic capabilities, and ensure equitable access to care. At the same time, the biomedical sciences are undergoing a data revolution. The increasing availability of complex, multi-modal biomedical data (from genomics and imaging to electronic health records) requires advanced analytical tools and methods to extract meaningful insights and translate them into clinical practice.

Artificial Intelligence (AI) is rapidly transforming medicine, from diagnostics and drug discovery to personalized treatment and healthcare delivery. As a key enabling technology, AI offers powerful tools to address the challenges outlined above. It supports innovation in medicine and biotechnology, accelerates the development of new therapies and medical devices, and contributes to sustainable improvements in healthcare systems.

The Elite Master's Program in AI in Biomedicine (AIBM) bridges the gap between computer science, engineering, and medicine to train future generations of AI experts who combine deep technical expertise in cutting-edge AI techniques with domain knowledge about biomedical applications. Our technical themes span the breadth and depth of AI, Machine Learning, Data Science and Engineering as well as underpinning disciplines: (a) Trustworthy AI that is accepted and adopted by clinicians, patients and citizens, (b) Human-Centered AI that addresses the opportunities of personalization for the individual and reflects the need for AI and Humans to interact to change healthcare outcomes, (c) Multi-Modal and Generative AI which addresses the emerging opportunities with AI systems that learn the underlying patterns and structures of their training data and use them to produce new data and (d) Foundations underpinning AI that develop and address the limitations of current AI systems, such as uncertainty quantification and causal reasoning.

Graduates of the AIBM program will be equipped to work at the interface of technology and medicine, developing innovative AI systems for biomedical and healthcare domains that address real-world healthcare challenges (including scientific knowledge, business expertise, industrial exposure). They will be trained to approach the deployment of AI technologies with a strong sense of ethical and social responsibility. Through interdisciplinary education and integrated soft-skills training, graduates will be empowered to responsibly implement innovations and contribute to the transformation of healthcare. With this comprehensive skill set, AIBM graduates will be qualified to take on a variety of roles, such as researchers in academia as well as in the pharmaceutical and medical device industry, developers of AI-based medical technologies and processes, consultants and managers in healthcare innovation, and entrepreneurs who drive responsible AI solutions in medicine.

The Elite Master's Program in AI in Biomedicine (AIBM) is highly research oriented. It is designed to prepare students for careers in academic research and high-impact industrial innovation. The program emphasizes independent scientific thinking, methodological rigor, and the ability to contribute to the advancement of AI technologies in biomedicine.

1.2 Strategic Significance

The Elite Master's program *AI in Biomedicine* at the TUM School of Computation, Information and Technology (CIT) is part of the *Professional Profile Data Science and Artificial Intelligence*. As part of its teaching strategy, CIT focuses on four scientific areas: Mathematics, Computer Science, Computer Engineering, and Electrical Engineering. Various Bachelor's programs are offered that establish a close connection between mathematics, computer science, information technology, and electrical engineering. These programs lay the foundation for consecutive and continuing education Masters programs. An overview of the CIT study programs can be found at: https://www.cit.tum.de/en/cit/studies/degree-programs/.

According to the teaching strategy of CIT, the school sees itself as "a driving force in tackling numerous challenges of our time"[1]. Accordingly, it is consistent to offer an attractive, English-language degree program with a strong research focus in the cutting-edge field of AI and machine learning (ML) and its applications in biomedicine, which can serve as a magnet for highly qualified national and international students. The subject area of AI in biomedicine has so far only been partially covered in the CIT, since the existing degree programs (e.g. Master's *Bioinformatics* and *Master's Informatics*) do not provide a comprehensive view of AI in biomedicine. For example, the Master's *Informatics* offers elective modules for *Digital Biology and Digital Medicine* or *Artificial Intelligence in Medicine*, but in-depth, interdisciplinary training that integrates biomedical application knowledge with advanced AI methodologies is not yet systematically provided. The new Master's program *AI in Biomedicine* aims to close this gap by systematically preparing the urgently needed specialists for the German and European biomedical sectors, paving the way for innovative, AI-driven solutions to address a wide range of interdisciplinary challenges in healthcare.

In line with TUM's guiding principles, students are to be educated as responsible, open-minded individuals who, as computer scientists, act in the spirit of innovation—demonstrating the highest standards of scientific rigor, technical expertise, entrepreneurial courage, and socio-political awareness. Our training program will enable them to emerge from their Elite Master's as future leaders in biomedical AI research in both the public and the private sector. It will bring about transformative change by equipping them with the technical AI skills and an understanding of regulatory, ethical and social questions, and embedding them in an ecosystem of industry, accelerator, regulator and healthcare partners. The theme for our Elite Master's Program arises from our strong engagement with our healthcare partners (two of the leading university hospitals in Bavaria), healthcare companies and start-ups. Thus, our Master's provides students with deep knowledge and understanding of AI and its applications in biomedicine.

Thanks to this innovative concept and the excellent track record of TUM and FAU, the program was selected for funding by the Elitenetzwerk Bayern, highlighting its excellence and strategic importance for the region's academic landscape and allowing the students to expand their networks beyond their technical subjects.

[1] https://www.cit.tum.de/en/cit/school/mission-statement/

The international orientation of the program makes a key contribution to the internationalization of the school's and TUM's teaching portfolio, as outlined in the mission statement of the TUM Teaching Constitution. It is specifically designed to attract English-speaking international students and prepare them for the German and European job markets in the field of biomedical AI, which is a rapidly expanding across Europe.

With its TUM Sustainable Futures Strategy 2030[2], TUM aims to support students in developing their own understanding of sustainability within their studies and to empower them to take an active and creative role in shaping this field. The new Elite Master's program AIBM includes the modules **"AI, Biomedicine and Society"** and **"Ethically Responsible Technology Translation"**, which provide students with the tools to critically engage with the broader impact of their work. These topics are not only addressed in the two modules mentioned but are also integrated into modules from the first and second semesters. Moreover, they form an integral part of the discussions within application projects and Master's theses.

The teaching of the Elite Master's program AIBM is hosted at the CIT and the FAU Department of Artificial Intelligence in Biomedical Engineering (AIBE). Both institutions are driving innovation at the intersection of AI, medicine, and engineering. TUM's School of CIT unites mathematics, informatics, and electrical engineering to tackle major societal challenges such as digital transformation and biomedical computing. Complementing this, AIBE focuses on applying artificial intelligence to real-world healthcare challenges, offering students a dynamic, interdisciplinary environment rooted in clinical relevance and ethical AI. In the area of AI and ML, both universities have established interdisciplinary research hubs such as the new FAU Department of Artificial Intelligence in Biomedical Engineering, TUM's Munich Data Science Institute (MDSI), the Munich Institute for Biomedical Engineering (MIBE) and the Munich Institute of Robotics and Machine Intelligence (MIRMI). These research centers are further supported through the BMBF-funded Munich Center for Machine Learning (MCML), one of Germany's six national AI Competence Centers. The MCML is funded permanently by the German and Bavarian governments' AI strategy and brings together leading ML researchers and over 100 outstanding AI researchers across Munich. One of the center's focus areas is the development of domain-specific AI, specifically in the area of biology & medicine, which is complemented by the Konrad Zuse School of Excellence in Reliable AI (relAI) at TUM, which aims to train future generations of experts in reliable and safe AI and covers the foundations as well as core application domains such as medicine & healthcare. Via TUM, the program is also closely integrated into the European Lab for Learning and Intelligent Systems (ELLIS). TUM has the TUM School of Social Sciences and Technology and thus possesses high expertise in Ethically and Socially Responsible Technology Development. Also outside TUM and FAU the combination of Erlangen and Munich provides a unique environment for data-driven research in medicine and healthcare. It encompasses four Max Planck Institutes in relevant areas (MPI for Biochemistry, MPI for Psychiatry, MPI for Biological Intelligence, and MPI for the Science of Light) and Helmholtz Munich, with its focus on AI in Biomedicine. Furthermore, all German Centers for Health Research (DZGs) have a partner site in Munich.

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https://mediatum.ub.tum.de/doc/1690440/1690440.pdf

2 Qualification Profile

The overall goal of the AI in Biomedicine program is to educate and train students in the interdisciplinary area between computer science (in particular AI and ML) and medicine & healthcare, thereby providing knowledge and skills and broadening their minds to envision and creating innovative applications of AI in Medicine and Healthcare. This will establish a new generation of diverse biomedical AI researchers, with skills ranging from computer science and mathematics to engineering and clinical medicine, as well as ethics and social responsibility.

The qualification profile of AIBM meets the requirements of the "Qualifications Framework for German Higher Education Degrees" (Hochschulqualifikationsrahmen – HQR) decided upon by the German Rectors' Conference and the Standing Conference of the Ministers of Education and Cultural Affairs (Hochschulrektorenkonferenz und Kultusministerkonferenz). In accordance with the HQR, the qualification profile for the research-oriented Elite Master's Program AIBM comprises the requirements (i) knowledge and understanding, (ii) implementation, application and production of knowledge, (iii) communication and cooperation and (iv) scientific self-understanding/professionalism. The formal aspects according to the HQR (admission requirements, length, graduation stipulations) are specified in chapters 3 and 6 and in the corresponding Degree Program and Examination Regulations.

(I) Knowledge and understanding

Upon completion of the Elite Master's program AIBM, graduates will possess a robust and interdisciplinary understanding that bridges computer science, artificial intelligence, mathematics, and selected areas of medicine. They have acquired targeted biomedical knowledge that is directly relevant to the development and application of AI technologies in medicine and healthcare. They understand the mathematical and algorithmic foundations of AI and can apply these methods to complex biomedical data. Graduates are familiar with clinical workflows and diverse medical data types, such as imaging data or electronic health records, and can analyze and integrate heterogeneous data sources within biomedical AI applications. Due to the comprehensive curriculum that covers the entire lifecycle of AI systems – from algorithm design and data engineering to deployment in clinical settings, graduates of the AIBM program are prepared to not just use AI tools, but to innovate and lead in their development.

Graduates possess the knowledge required to critically assess the ethical, legal, and societal implications of AI technologies in biomedicine. They understand the principles of responsible research and innovation and are equipped to apply these in the development and deployment of AI systems. Furthermore, they have a solid grasp of regulatory frameworks governing AI-based medical technologies, enabling them to navigate the complex landscape of healthcare innovation with confidence and responsibility.

Through this combination of foundational knowledge, applied skills, and ethical awareness, graduates are well-prepared to contribute to the development of innovative, responsible, and impactful AI solutions in the biomedical domain. They possess expertise that is purposefully aligned with addressing complex real-world challenges of significant societal relevance, such as the integration of multimodal patient data, the development of interpretable AI models for clinical use, and the ethical deployment of AI technologies in sensitive medical contexts, enabling them to drive progress at the intersection of technology, medicine, and society.

Specialized Knowledge

All students in the *AI in Biomedicine* program acquire foundational knowledge in the core areas of artificial intelligence for biomedical applications. Given the diverse professional roles in this interdisciplinary field, which often require specialized expertise in a particular domain of AI or biomedical application, students choose a focus subject that allows them to deepen their knowledge in a targeted way. Depending on their selection, they develop comprehensive competencies in one of the following domains: *Advanced Machine Learning*, *Drug Discovery and Computational Biology*, *Imaging and Sensing*, or *Natural Language Processing and Speech*. By the end of their studies, graduates possess in-depth expertise in their chosen specialization.

Focus Subject Advanced Machine Learning: Graduates who focus on advanced machine learning possess a deep understanding of state-of-the-art AI methods, such as deep generative models, optimization techniques, and 3D geometry learning. They are able to design, implement, and critically evaluate advanced machine learning algorithms for complex biomedical data and applications. Furthermore, they can adapt and extend existing AI models to novel biomedical challenges, ensuring robust and interpretable solutions in research and clinical contexts.

Focus Subject Drug Discovery and Computational Biology: Graduates who focus on drug discovery and computational biology have acquired comprehensive knowledge of computational methods for analyzing biological data, such as single-cell biology, genomics, and protein structure prediction, and can apply machine learning techniques to identify drug targets. Additionally, they can integrate diverse biological datasets and develop computational pipelines to support innovative biomedical research and drug development.

Focus Subject Imaging and Sensing: Graduates who focus on imaging and sensing have a deep understanding of advanced methods for medical image analysis, computer vision, and sensor data processing. They are able to develop and apply AI-based techniques for tasks such as image segmentation, detection, tracking, and augmented reality in medical settings. Moreover, they can interpret and integrate imaging data from various imaging modalities.

Focus Subject Natural Language Processing and Speech: Graduates who focus on natural language processing (NLP) and speech possess in-depth expertise in the analysis and interpretation of text and spoken language data. They are able to develop and implement advanced NLP and speech processing algorithms for extracting meaningful information from unstructured medical data. Furthermore, they can design AI-driven solutions to support clinical decision-making and patient communication**.**

(II) Implementation, application and production of knowledge

The specialized knowledge as well as the soft skills acquired through the program equip graduates to devise innovative, often unconventional, and entirely novel solutions to complex challenges within the interdisciplinary domain of artificial intelligence and biomedicine. Through active involvement in research-driven, interdisciplinary projects (i.e. the module section Clinical applications in Biomedicine and Health and the Clinical Applications project in Cardiology, Neurology or Oncology), graduates of the AIBM program acquire the practical expertise needed to apply AI methods effectively in biomedical contexts. They are able to design and manage research projects, including formulating research questions, overseeing data collection and analysis, and effectively

disseminating results to both scientific and non-scientific audiences. Moreover, they possess key qualifications such as communication and organizational skills, leadership, and the ability to critically reflect on the use of artificial intelligence. Additionally, graduates possess a deep familiarity with state-of-the-art methodologies in AI and machine learning, such as deep generative models, mutli-modal AI or transfer learning, and can apply these approaches in a focused and largely autonomous manner to real-world problems and emerging challenges. Simultaneously, the program fosters their ability to advance scientific innovation by developing solutions to pressing research questions with direct relevance to the healthcare sector. Graduates are adept at selecting appropriate research methodologies and critically evaluating their findings, ensuring both scientific rigor and practical impact. This leaves them with outstanding opportunities for a future career in academia or industry.

(III) Communication and cooperation

Graduates excel in interdisciplinary communication and demonstrate the ability to collaborate constructively and solution-oriented within diverse teams, including engineers, computer scientists, and medical professionals. They are well-versed in the technical terminology, methodologies, and disciplinary perspectives relevant to complex problems at the interface of computer science and biomedicine, and can act as effective mediators across these domains. Within the context of academic and professional work, they are capable of effectively communicating scientific results – both orally and in writing – while tailoring their message to the needs of specific audiences. Graduates are able to engage in critical discussion and debate and contribute to joint problem-solving in interdisciplinary settings.

In addition, through external research projects and Master's theses, as well as colloquia and excursions, graduates establish contacts with research institutions and companies both within and outside of Germany. They develop advanced international competencies and exhibit a high degree of intercultural awareness, including the ability to recognize and navigate diverse cultural norms and expectations. They are trained to identify potential sources of conflict in interdisciplinary collaboration, including differing expectations, ethical concerns, and societal sensitivities related to the use of AI in medicine. This includes a deep understanding of the principles of trustworthy AI, enabling them to anticipate and address issues of transparency, fairness, and accountability in biomedical applications.

(IV) Scientific self-understanding/professionalism

Our Elite Master's program is designed to cultivate the next generation of leaders in biomedical AI research across both the public and private sectors. Graduates emerge with the ability to critically analyse the current state of research within their area of specialization, formulate novel research questions, and translate these into concrete, application-driven solutions. They are equipped to conduct rigorous scientific inquiry and to pioneer innovative approaches in artificial intelligence and machine learning. Moreover, they demonstrate adaptability to the rapidly evolving landscape of biomedical AI and engage in reflective professional practice that considers regulatory, ethical, and societal dimensions.

Graduates critically reflect and evaluate their professional actions in light of societal expectations and consequences. They are able to act with foresight and responsibility in conflict situations, considering economic and social factors. They can assess the ethical and societal opportunities and risks of the technologies they develop, and can make informed, responsible decisions regarding the continuation of ideas or the deployment of AI systems in sensitive biomedical contexts. These

competencies are fostered through dedicated modules such as *Trustworthy AI for Medicine, AI, Biomedicine and Society* or *Medical Device and AI Regulation*, which provide students with the tools to navigate complex ethical landscapes and contribute to trustworthy AI development in healthcare. Their work is embedded within a dynamic ecosystem of industry stakeholders, accelerators, regulatory bodies, and healthcare partners—ensuring relevance, responsibility, and impact.

3 Target Groups

3.1 Target Audience

For the Elite Master's program AIBM we are seeking highly motivated students with outstanding Bachelor's degrees in technical disciplines who aspire to deepen their expertise in artificial intelligence within the context of biomedicine. To attract top-tier candidates and foster a diverse academic environment, the program will be promoted both nationally and internationally.

This Master's program is designed for students from around the world who have completed a foundational university education – typically with a Bachelor's degree or equivalent qualification – in fields such as Computer Science, Electrical and Information Engineering, or related disciplines. The program is taught exclusively in English, and applicants must provide proof of advanced English language proficiency, equivalent to at least level C1.

3.2 Prerequisites

Applicants to the AIBM Master’s program are expected to demonstrate a strong academic foundation and a clear motivation to engage with cutting-edge research at the intersection of artificial intelligence and biomedicine. Ideal candidates will show a deep interest in machine learning and AI, particularly in their application to biomedical challenges. They must possess excellent English language skills (comparable to level C1), as the program is conducted entirely in English, and be capable communicators – both in interdisciplinary academic contexts and collaborative team environments.

Successful applicants will also exhibit interdisciplinary competencies, the ability to work effectively in diverse teams, and a proven track record of academic achievement, research experience, or meaningful extracurricular engagement that reflects their commitment to innovation and societal impact.

As part of the aptitude assessment process, applicants must provide evidence of having successfully completed a technically oriented Bachelor's degree program, such as a Bachelor’s in computer science or electrical and information engineering.

All applicants must demonstrate a solid background in computer science, machine learning and artificial intelligence. This includes strong knowledge in core computer science principles, including algorithms and common data structures, mathematical principles, and have experience in machine learning and artificial intelligence.

For applicants with a different academic background a comparison is made with one or more of the core qualifications listed above. This approach ensures a fair evaluation of competencies, especially for interdisciplinary degree programs. It is essential that applicants have a solid foundation in mathematics and computer science, as well as sufficient knowledge in machine learning and AI.

Suitability is assessed in a first step through the above described analysis of the curriculum, the CV, a motivation letter, and an essay on a current topic in the field of AI in biomedicine. I the second step of the admission process students are invited to a personal interview.

3.3 Target Numbers

The expected number of enrolled students is around 30 per year. With this small cohort size, we can offer high-quality mentoring and supervision, and provide sufficient independent and individually challenging research projects – with a large fraction of those at our international collaborating or industry partners. All hands-on practical courses will be offered in multiple parallel sessions with only a few students each; to facilitate interactions between instructors and students (we expect 3 to 4 sessions of ≤ 10 students each). Excursions and retreats, student-organized events, and colloquia are well feasible with this student count, both within one student cohort and across the two cohorts (years 1 and 2).

4 Demand Analysis

The ongoing digital transformation of the healthcare sector, coupled with the accelerated adoption of AI technologies, is fundamentally reshaping the requirements for future professionals and the demand for highly qualified engineers and scientists with expertise at the intersection of AI, computer science and medicine & healthcare is rapidly growing. Between 2019 and 2023, the demand for AI experts - regardless of their specialisation - increased by approximately 50%, according to an analysis of the "Institut der deutschen Wirtschaft".[3] This trend is expected to continue: by 2026, up to 780,000 additional technology specialists will be required in Germany, with a particularly strong demand for data analysts and AI experts. In response to these developments, leading organizations such as the Stifterverband and McKinsey advocate for a significant expansion of technology-oriented study programs and continuing education opportunities.[4] These recommendations align with national strategies, including the https://www.ki-strategie-deutschland.de/ of the German Federal Ministry of Research and Education (BMBF) and in the HighTech Agenda of the Free State of Bavaria, both of which emphasize the necessity of preparing professionals for emerging technological challenges.

In addition to national policy initiatives, there is also a significant and urgent demand from industry for graduates with interdisciplinary expertise in AI and biomedicine: Several companies have already expressed strong support for this program and interest in their graduates, including IT companies, MedTech & Pharma companies, as well as SMEs and networks that connect industry and universities and promote startups. For example, the Medical Valley in the Erlangen region forms a national center of excellence in medical engineering (established in 2010 with €80M funding from the BMBF) and has created a successful ecosystem of world-leading healthcare companies, as well as BioM and BAIosphere. All these companies operate internationally, most of them located in Bavaria or having local seats in Bavaria.

The need for highly qualified graduates is not limited to industry alone. The scientific community also faces a growing demand for experts who can bridge the gap between AI, computer science, and biomedicine. As biomedical research becomes increasingly data-driven and reliant on advanced computational methods, there is a pressing need for professionals who possess both deep technical expertise and a solid understanding of medical and biological contexts. Graduates with interdisciplinary training are essential for driving innovation in areas such as personalized medicine, biomedical data analysis, and the development of novel diagnostic and therapeutic approaches. By equipping students with these sought-after skills, the AIBM program will contribute significantly to advancing both scientific discovery and translational research.

Graduates of AIBM are trained to pursue careers beyond conventional job markets, including roles in cutting-edge research, startups, policy-making, and global health innovation, making them key contributors to shaping the future of healthcare and technology.

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[3] Institut der deutschen Wirtschaft, 27.12.2023, https://www.iwd.de/artikel/ki-boom-unternehmen-suchen-fachkraefte-606812/

[4] Stifterverband & McKinsey, Pressemitteilung, 24.11.2021, https://www.stifterverband.org/pressemitteilungen/2021_11_24_tech-spezialisten

5 Competition Analysis

5.1 External Competition Analysis

While numerous universities worldwide offer Master's programs that touch on AI and biomedicine, the Elite Master's Program in AI in Biomedicine (AIBM) – jointly offered by TUM and FAU – stands out as a uniquely structured and forward-looking initiative.

Comparable study programs exist in Germany, Europe and worldwide. Most of the programs focus on specific applications like neuroscience (Charité Berlin) or Analytics and Hospital Management (National University of Singapore) or only offer specialization tracks in the field of AI in biomedicine (KU Leuven, ETH Zurich). In the following the key features of the Elite Master's program AIBM is compared to other programs.

Unlike most programs, AIBM is part of the Elite Network of Bavaria, a prestigious initiative that supports top-tier academic training for exceptional students. This elite status ensures small cohorts, personalized mentoring, and access to exclusive resources, setting it apart from larger, more generalized programs at other Institutions.

While programs such as Stanford's Biomedical Informatics or Oxford's Biomedical Data Science focus on specific aspects of AI application, AIBM offers a comprehensive curriculum that covers the entire lifecycle of AI systems – from algorithm design and data engineering to deployment in clinical settings. This holistic approach prepares students not just to use AI tools, but to innovate and lead in their development.

AIBM places strong emphasis on ethics, social responsibility, and leadership, preparing graduates to navigate the complex societal implications of AI in healthcare. While other programs may offer optional ethics courses, AIBM embeds these themes into its core curriculum, ensuring that graduates are not only technically proficient but also socially conscious innovators.

The program's focus on entrepreneurship, science communication, and public engagement equips students to become leaders in shaping the future of AI in medicine, rather than simply participating in it.

The joint offering by TUM and FAU brings together two of Germany's strongest institutions in AI, engineering, and medicine. This collaboration provides students with access to diverse faculty expertise, state-of-the-art labs, and industry partnerships.

5.2 Internal Competition Analysis

The AIBM Elite Master's Program is closely interconnected with the fundamental computer science programs at TUM and FAU, as well as the Bachelor's programs in Artificial Intelligence and Medical Technology at FAU. The foundation in AI provided by existing Bachelor's programs enables seamless academic progression for students from these programs. However, AIBM is distinctly different from existing, related Master's programs – such as *Bioinfomatics* (TUM), *Biomedical Engineering and Medical Physics* (TUM), *Medical Engineering* (TUM/FAU), *Mechatronics, Robotics and Biomechanical Engineering* (TUM), *Data Engineering and Analytics* (TUM), *Artificial Intelligence*

(FAU) or general Computer Science Master's programs at TUM and FAU, which primarily focus on either foundational methodologies or method application in biomedicine that may include AI but do not emphasize it as the core element with its application to biomedicine.

While *Bioinformatics* (TUM) primarily focuses on computational methods for life sciences (molecular and genomic data analysis, system biology, biochemistry), AIBM takes a broader approach by integrating artificial intelligence across the full spectrum of biomedicine, including life science applications as well as biomedical imaging, sensing, language, and clinical applications. In contrast to *Biomedical Engineering and Medical Physics* (TUM) and *Medical Engineering* (TUM/FAU), which emphasize physical principles of imaging technologies, instrumentation, and medical device development, AIBM focuses on data-driven AI methodologies and their application in diagnostics and therapy. Compared to *Mechatronics, Robotics and Biomechanical Engineering* (TUM), which is centered on mechanical systems and robotic design, AIBM also covers intelligent data analysis and AI-based decision support in biomedical contexts. Unlike *Data Engineering and Analytics* (TUM), which addresses general-purpose data processing across disciplines, AIBM specifically targets complex biomedical data with clinical relevance. Similarly, while the *Artificial Intelligence* Master's program (FAU) provides a broad foundation in AI theory and generic applications, AIBM applies these methods in depth to biomedical and healthcare challenges, integrating technical expertise with interdisciplinary knowledge. Finally, while the general Computer Science Master's programs at TUM and FAU cover a wide range of computing disciplines, AIBM offers a focused curriculum that systematically connects AI with biomedicine, thereby preparing graduates for cutting-edge research and innovation at the intersection of technology and healthcare.

AIBM students will be able to take advantage of the large number of courses offered in these related programs for their focus subjects.

6 Program Structure

The curriculum is designed to achieve the three core goals of (1) providing a coherent yet flexible and personalized training, (2) offering early exposure to real-world challenges in biology, medicine and healthcare, including ethics and social responsibility and (3) fully embracing the international scope of AI in these applications. It will take full advantage of the complementary expertise of the partners at the partnering institutions, who will ensure that a great variety of courses will be offered regularly such that candidates will have the possibility to fulfil the curriculum while pursuing their individual research interests.

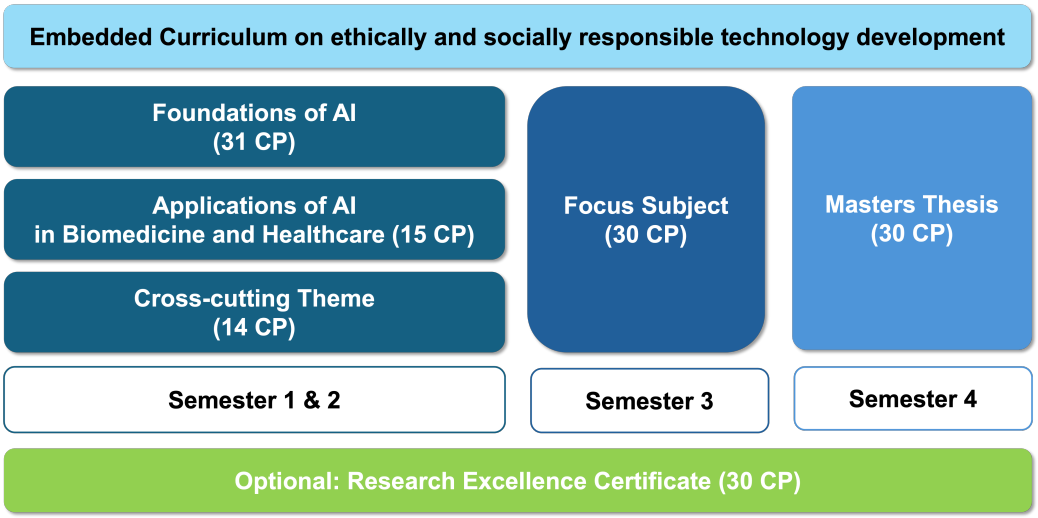

Figure 1: Overview of the Elite Master's For AI in Biomedicine.

The program comprises 4 semesters and a total of 120 credit points (CP), with the Master's thesis accounting for 30 CP. The curriculum will be divided into four main topics (see also Figure 1): *Foundations of AI* courses offer knowledge about algorithmic and mathematical aspects of AI, while the *Applications of AI in Biomedicine and Healthcare* introduce students to AI implementations in the medical and health sectors. Additionally, students will choose a *Focus Subject* to gain in-depth insights into foundations and/or applications of AI. Finally, the *Cross-Cutting Theme* enables students to gain skills in entrepreneurship & innovation, science communication, public and patient engagement. The curriculum is rounded off by the *Master's thesis* at one of the two institutions, or at one of our academic or industry partners. Each thesis will be co-supervised by a medical partner, as well as by additional extracurricular activities, including student-organized summer schools, and weekend seminars focusing on skills such as project management as well as communication and conflict management.

In addition to their core modules, students can further tailor their learning through studies in dedicated focus areas, Master's seminars, and a diverse array of elective courses that are available from both TUM and FAU. The focus area allows specialization in one of four domains: Advanced Machine Learning, Drug Discovery and Computational Biology, Imaging and Sensing, or NLP and Speech. Throughout the lifetime of AIBM, the steering committee will continue to review the courses available at TUM and FAU, and will add new specialized courses whenever new, relevant topics emerge. This means that students will always be offered a broad selection of courses at the cutting-edge of science and technology.

All courses offered in collaboration or exclusively by FAU in the first two semesters will be held in a hybrid format, as block modules in Munich or a mixed format (introduction and final presentations in person in Munich and ongoing course work in a hybrid format).

Semester	Modules						Credits/ number of exams
1.	**Foundations of AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**AI, BM & Society** exclusive (mandatory) Sci. report TUM 3 CP	**Multimodal AI** exclusive (mandatory) Exam TUM/FAU 5 CP	**Trustworthy AI for Medicine** open to other students (mandatory) Exam TUM 5 CP	**Applications of AI** exclusive (elective) Presentation TUM 5 CP	**Skills and Methods** exclusive (mandatory) Projectwork TUM 4 ECTS	30/6
2.	**Advanced AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**Ethics and AI** exclusive (mandatory) Exam FAU 3 CP	**Human-centered AI** exclusive (mandatory) Presentation FAU 5 CP	**Applications of AI** exclusive (elective) Projectwork TUM/FAU 5 CP	**Applications of AI** open to other students (elective) Projectwork TUM 5 CP	**Cross-cutting** exclusive (elective) Projectwork TUM/FAU 4 CP	30/6
3. Mobility window	**Clinical applications project in Cardiology/Neurology/Oncology** exclusive (mandatory) Projectwork TUM/FAU/international or academic partners 15 CP			**Focus** (elective) 5 CP	**Focus** (elective) 5 CP	**Masters Seminar** (elective) 5 CP	30/4
4.	Masters Thesis 30 CP						30/1
Key:	Foundations of AI	Applications of AI	Cross-cutting themes	Focus subject	Masters thesis		

Table 1: Sample degree chart for a four-semester AIBM program.

Semester	Modules						Credits/ number of exams
1.	**Foundations of AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**AI, BM & Society** exclusive (mandatory) Sci. report TUM 3 CP	**Multimodal AI** exclusive (mandatory) Exam TUM/FAU 5 CP	**Trustworthy AI for Medicine** open to other students (mandatory) Exam TUM 5 CP	**CA - Interventions & Therapy** open to other students (elective) Presentation TUM 5 CP	**Skills and Methods** exclusive (mandatory) Projectwork TUM 4 ECTS	30/6
2.	**Advanced AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**Ethics and AI** exclusive (mandatory) Sci. report FAU 3 CP	**Human-centered AI** exclusive (mandatory) Presentation FAU 5 CP	**CA - Diagnosis** open to other students (elective) Projectwork TUM/FAU 5 CP	**Comp. Biology and Pathology** exclusive (elective) Oral Exam TUM 5 CP	**Cross-cutting** exclusive (elective) Projectwork TUM/FAU 4 CP	30/6
3. **Mobility window**	**Clinical applications project in Cardiology/Neurology/Oncology** exclusive (mandatory) Projectwork TUM/FAU/international or academic partners 15 CP			**Advanced Deep Learning** (elective) Exercices FAU 5 CP	**Machine Learning and Optimization** (elective) exam TUM 5 CP	**Masters Seminar** Trustworthy AI for Medicine (elective) 5 CP	30/4
4.	Masters Thesis 30 CP						30/1
Key:	Foundations of AI	Applications of AI	Cross-cutting themes	Focus subject	Masters thesis		

Table 2: Sample degree chart for a four-semester AIBM program with the focus subject *Advanced Machine Learning*.

Semester	Modules						Credits/ number of exams
1.	**Foundations of AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**AI, BM & Society** exclusive (mandatory) Sci. report TUM 3 CP	**Multimodal AI** exclusive (mandatory) Exam TUM/FAU 5 CP	**Trustworthy AI for Medicine** open to other students (mandatory) Exam TUM 5 CP	**CA - Interventions & Therapy** open to other students (elective) Presentation TUM 5 CP	**Skills and Methods** exclusive (mandatory) Projectwork TUM 4 ECTS	30/6
2.	**Advanced AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**Ethics and AI** exclusive (mandatory) Sci. report FAU 3 CP	**Human-centered AI** exclusive (mandatory) Presentation FAU 5 CP	**CA - Diagnosis** open to other students (elective) Projectwork TUM/FAU 5 CP	**Comp. Biology and Pathology** exclusive (elective) Oral Exam TUM 5 CP	**Cross-cutting** exclusive (elective) Projectwork TUM/FAU 4 CP	30/6
3. **Mobility window**	**Clinical applications project in Cardiology/Neurology/Oncology** exclusive (mandatory) Projectwork TUM/FAU/international or academic partners 15 CP			**Machine Learning and Optimization** (elective) exam TUM 5 CP	**Fundametals of Physiology, Bio-chemistry, and MoI.** (elective) Oral Exam TUM 5 CP	**Masters Seminar** Multi-modal AI for Medicine (elective) 5 CP	30/4
4.	Masters Thesis 30 CP						30/1
Key:	Foundations of AI	Applications of AI	Cross-cutting themes	Focus subject	Masters thesis		

Table 3: Sample degree chart for a four-semester AIBM program with the focus subject *Drug Discovery and Computational Biology*.

Semester	Modules						Credits/ number of exams
1.	**Foundations of AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**AI, BM & Society** exclusive (mandatory) Sci. report TUM 3 CP	**Multimodal AI** exclusive (mandatory) Exam TUM/FAU 5 CP	**Trustworthy AI for Medicine** open to other students (mandatory) Exam TUM 5 CP	**CA - Interventions & Therapy** open to other students (elective) Presentation TUM 5 CP	**Skills and Methods** exclusive (mandatory) Projectwork TUM 4 ECTS	30/6
2.	**Advanced AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**Ethics and AI** exclusive (mandatory) Sci. report FAU 3 CP	**Human-centered AI** exclusive (mandatory) Presentation FAU 5 CP	**CA - Diagnosis** open to other students (elective) Projectwork TUM/FAU 5 CP	**Comp. Biology and Pathology** exclusive (elective) Oral Exam TUM 5 CP	**Cross-cutting** exclusive (elective) Projectwork TUM/FAU 4 CP	30/6
3. Mobility window	**Clinical applications project in Cardiology/Neurology/Oncology** exclusive (mandatory) Projectwork TUM/FAU/international or academic partners 15 CP		**Pattern Recognition** (elective) Exam FAU 5 CP	**Medical Augmented Reality** (elective) Exam TUM 5 CP	**Masters Seminar** Machine Learning in Neuroimaging (elective) 5 CP		30/4
4.	Masters Thesis 30 CP						30/1
Key:	Foundations of AI	Applications of AI	Cross-cutting themes	Focus subject	Masters thesis		

Table 4: Sample degree chart for a four-semester AIBM program with the focus subject *Imaging and Sensing*.

Semester	Modules						Credits/ number of exams
1.	**Foundations of AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**AI, BM & Society** exclusive (mandatory) Sci. report TUM 3 CP	**Multimodal AI** exclusive (mandatory) Exam TUM/FAU 5 CP	**Trustworthy AI for Medicine** open to other students (mandatory) Exam TUM 5 CP	**CA - Interventions & Therapy** open to other students (elective) Presentation TUM 5 CP	**Skills and Methods** exclusive (mandatory) Projectwork TUM 4 ECTS	30/6
2.	**Advanced AI in Biomedicine** exclusive (mandatory) Projectwork TUM 8 CP	**Ethics and AI** exclusive (mandatory) Sci. report FAU 3 CP	**Human-centered AI** exclusive (mandatory) Presentation FAU 5 CP	**CA - Diagnosis** open to other students (elective) Projectwork TUM/FAU 5 CP	**Comp. Biology and Pathology** exclusive (elective) Oral Exam TUM 5 CP	**Cross-cutting** exclusive (elective) Projectwork TUM/FAU 4 CP	30/6
3. **Mobility window**	**Clinical applications project in Cardiology/Neurology/Oncology** exclusive (mandatory) Projectwork TUM/FAU/international or academic partners 15 CP			**Machine Learning and Optimization** (elective) exam TUM 5 CP	**Auditory System** (elective) Oral Exam TUM 5 CP	**Masters Seminar** NLP - Methods and Applications (elective) 5 CP	30/4
4.	Masters Thesis 30 CP						30/1
Key:	Foundations of AI	Applications of AI	Cross-cutting themes	Focus subject	Masters thesis		

Table 5: Sample degree chart for a four-semester AIBM program with the focus subject *Natural language processing and speech*.

Foundations of AI

This module area provides the essential foundations for later application modules. It covers fundamental concepts in algorithmic and mathematical aspects. To solidify theoretical learning and enhance practical competence, every core course is paired with accompanying research projects designed for small groups. These projects allow students to immediately apply learned concepts in realistic healthcare settings, thereby deepening their understanding of complex AI methodologies while addressing tangible clinical challenges. Under the close supervision of both methodological and clinical faculty, students engage in iterative, hands-on projects that simulate real-world problem-solving. The five offered modules are mandatory.

Foundations of AI in Biomedicine: The curriculum begins with an Introduction to Clinical Motivation and Workflows, which explores the clinical context, types of clinical data, and the structure of clinical workflows. Building on this foundation, the applications part of the module delves into techniques for medical imaging, data curation, and learning from sparse or noisy datasets, as well as approaches for handling unstructured and multi-modal clinical data. Additionally, the NLP for Clinical Data area focuses on applying NLP techniques specifically to clinical datasets, enabling deeper insights and more effective data utilization in medical contexts.

Advanced AI in Biomedicine: This advanced module explores key topics in modern AI for healthcare, beginning with domain shift, including adversarial and transfer learning techniques, as well as self-supervised and unsupervised learning approaches. It further introduces Bayesian

methods and emphasizes the importance of interpretability in clinical AI systems. A significant focus is placed on privacy and reliability in AI, covering federated learning, privacy-preserving machine learning, ethical considerations, time-to-event modeling, survival analysis, differential diagnosis, patient stratification, computational privacy, and the development of robust and trustworthy AI solutions.

Human-centered AI: This module emphasizes Human-in-the-Loop Machine Learning and Human-centered AI, highlighting techniques such as active learning and data annotation to integrate human expertise into the AI development process. It also explores transfer learning, the use of embeddings, and strategies for enhancing human annotation through machine learning support. A particular focus is placed on computer vision and medical image processing, addressing both technical methods and practical applications. The module concludes with a critical examination of the challenges faced in real-world AI deployments, preparing students to navigate complex, dynamic environments in healthcare and beyond.

Trustworthy AI for Medicine: This module centers on trustworthy machine learning in healthcare, with a strong emphasis on privacy, fairness, and reliability. It covers advanced topics such as privacy-preserving machine learning, memorization and sample influence in deep learning, and the detection and mitigation of algorithmic bias. Students gain a comprehensive understanding of both ethical and technical considerations necessary for developing responsible and trustworthy AI systems in medical contexts.

Multi-modal AI: This module introduces key healthcare data types, including data acquisition methods, medical imaging, speech recognition, and clinical notes. It emphasizes the integration of heterogeneous data sources and the development of effective AI models tailored to complex medical datasets. Students explore both neural and traditional supervised/unsupervised learning approaches, gaining practical skills in modeling diverse clinical data for real-world applications.

Applications of AI in Biomedicine and Healthcare

These modules are offered during the first two semesters and serve as an introduction to AI applications in the medical and healthcare sectors. Students are required to earn a total of 15 ECTS credits, which can be fulfilled by selecting from the following AIBM courses: Computational Biology and Pathology, Computer-Assisted Diagnosis, Computer-Assisted Interventions & Therapy, and Medical Data Science. In addition to technical qualifications, this program also provides a solid foundation in biomedical knowledge.

Depending on the selected courses, some modules may be exclusive to AIBM students, while others may be open to interested students from other programs.

Computational Biology and Pathology: This module provides an introduction to digital pathology, covering essential topics such as quality control, workflow design, and user interfaces. Students will learn AI techniques and their applications in pathology, including patch-level and whole-slide image (WSI) classification, feature extraction, and the training of downstream models for diagnostic and analytical purposes.

Computer-Assisted Diagnosis (CAD): This module begins with the theoretical foundations of computer-assisted diagnosis (CAD), followed by exploration of key topics in modern CAD systems. Students actively engage through presentations and discussions on current research, with a strong

emphasis on interactive learning. The course covers advanced areas such as multimodal CAD, fairness in AI, pretraining techniques, and generative CAD for anomaly detection. It culminates in a group project, where students collaboratively design and prototype a CAD system using large language models (LLMs).

Computer-Assisted Interventions & Therapy: This module focuses on computer-assisted interventions and therapy, combining theoretical knowledge with hands-on experience. Students engage in practical projects such as camera-based surgery, surgical navigation, tracking systems, medical augmented reality (AR), and robot-assisted rehabilitation. The course emphasizes the use of methodological tools to identify and implement effective technical solutions for real-world clinical challenges.

Medical Data Science: This module focuses on Medical Documentation and Information Systems, covering essential topics such as medical information models, clinical terminologies, and IT systems that support medical research. Students gain insights into various data types, the role of information systems in clinical research, and the fundamentals of statistical analysis and data visualization. Additionally, the module addresses regulatory frameworks for data processing, including data protection laws and the implications of the AI Act in healthcare contexts.

Cross-cutting themes

The Cross-Cutting Theme enables students to gain skills in entrepreneurship & innovation, leadership, science communication, public and patient engagement. Exclusive AIBM modules are Medical Device & AI Regulation and Entrepreneurship & Innovation in Medicine and Healthcare. An essential aspect of the curriculum is the education of students in the context of ethically and socially responsible technology development and use. For this, the curriculum will contain two dedicated courses in the first and second semester, as well as embed sessions on ethically and socially responsible research and innovation within each course.

Entrepreneurship & Innovation in Medicine and Healthcare: This module introduces the Foundations of Entrepreneurship in Healthcare, covering the basics of entrepreneurship, healthcare-specific business models, and innovation strategies tailored to the medical sector. It also explores AI-Driven Healthcare Solutions, focusing on the development and commercialization of AI-based medical technologies. Key topics include market analysis, regulatory considerations, and strategies for bringing innovative AI solutions to the healthcare market.

Medical Device and AI Regulation: This module focuses on the legal and regulatory frameworks surrounding medical devices, emphasizing risk management, patient safety, and regulatory compliance. It covers the full clinical evaluation and product life cycle, including market introduction and ongoing product oversight, with a particular focus on the role of software in medical technologies and the associated regulatory challenges. Additionally, the module explores the EU AI Act and its implications for the development and deployment of AI-driven medical technologies.

AI, Biomedicine and Society: Exploring the Social and Political Dimensions of AI in Biomedicine: Exploring the Social and Political Dimensions of AI in Biomedicine: This module offers an introduction to Science and Technology Studies (STS), focusing on the social and political implications of AI and digital technologies in biomedicine. It examines the broader impact of science and technology on society and healthcare, encouraging critical reflection on innovation processes.

A key emphasis is placed on socially responsible research and innovation, promoting inclusive, ethical, and socially engaged approaches to biomedical advancement.

Ethics of AI: This module explores the ethical and philosophical dimensions of AI, introducing students to fundamental ethical theories and the key challenges in AI ethics. It encourages critical reflection on concepts such as autonomy, responsibility, and the societal impact of AI technologies. Core topics include fairness, bias, transparency, accountability, and the regulation of AI, providing a comprehensive foundation for understanding and addressing ethical concerns in the development and deployment of AI systems.

Research Skills and Methods: This module equips students with essential scientific and methodological skills for conducting and communicating research. It covers principles of good scientific practice, including data integrity and reproducibility. Students will learn how to effectively present their work through academic posters, scientific writing, and oral presentations. Practical sessions include hands-on training in literature review, critical analysis, and the use of collaborative tools for interdisciplinary research.

Project Management: In this module the students acquire basic skills and knowledge in project management. The module covers international quasi-standards for project management, an overview of typical project phases, software tools for project management and time management. Moreover, students learn how to control and ensure quality and success and how to plan and manage resources.

Focus subjects

The focus area allows specialization in one of four domains: *Advanced Machine Learning*, *Drug Discovery and Computational Biology*, *Imaging and Sensing*, or *NLP and Speech*. Each focus area combines theoretical foundations acquired through specialized elective courses with hands-on, research-oriented training provided in the Master's seminar and the clinical applications project.

In the focus area *Advanced Machine Learning*, students explore advanced algorithms, state-of-the-art deep learning model architectures, and optimization strategies. They learn how to design and evaluate state-of-the-art machine learning methods for complex biomedical data and applications. Moreover, students learn to adapt and extend existing AI models to ensure robust and interpretable solutions for biomedical challenges. In this focus area, students can, for instance, choose from the following modules: Advanced Machine Learning: Deep Generative Models, Introduction to Deep Learning, Machine Learning, Machine Learning and Optimization, Machine Learning for 3D Geometry and Advanced Robot Learning and Decision-Making. Students can also choose modules from FAU, for instance: Deep Learning and Advanced Deep Learning.

The *Drug Discovery and Computational Biology* focus area covers computational methods for single-cell biology and genomics, protein prediction, and drug design chemistry. Students acquire practical skills in integrating heterogeneous biological datasets and building computational pipelines for drug discovery. They also learn to apply AI methods to identify potential drug targets and support innovative biomedical research. In this focus area, students can, for instance, choose from the following modules: Computational Methods for Single-cell Biology, Machine Learning for Regulatory Genomics, Protein Prediction II for Bioinformaticians, Neural Signals, Drug Discovery Chemistry,

Fundamentals and Methods of Physiology, Biochemistry, and Molecular Biology, and Machine Learning and Optimization.

The focus area *Imaging and Sensing* focuses on advanced deep learning for computer vision, computer-aided medical procedures and medical imaging technology. Students learn to develop AI-based methods for segmentation, detection, and tracking in multimodal imaging data. In addition, they acquire the ability to interpret imaging data from various modalities to support clinical applications. In this focus area, students can, for instance, choose from the following modules: Advanced Deep Learning for Computer Vision: Visual Computing, Computer Vision II: Multiple View Geometry (3D Computer Vision), Computer Vision III: Detection, Segmentation, and Tracking, Computer Aided Medical Procedures, Computer Aided Medical Procedures II, Medical Augmented Reality, Medical Imaging Technology, and Biomedical Physics 1. Students can also choose modules from FAU, for instance: Pattern Recognition, Flat Panel CT, and Pattern Analysis.

Finally, the focus area *NLP and Speech* covers foundational and advanced algorithms and deep learning architectures for natural language as well as speech processing. Students develop skills to analyze and interpret unstructured medical text and spoken language data. They also learn to design AI-driven tools for clinical decision support and patient interaction based on language and speech technologies. In this focus area, students can, for instance, choose from the following modules: Natural Language Processing, Advanced Natural Language Processing, Communication Acoustics, The Auditory System, and Machine Learning and Optimization.

Within these four focus areas, students can deepen or broaden their technical and methodological expertise according to their individual interests. An individual study plan is comprised for each student in close collaboration with the personal mentor. This structure allows students not only to gain a foundational level of interdisciplinary knowledge across all areas but also to define their own focus within the broader field of AI in Biomedicine.

The elective catalogs are continuously updated by the examination board. Special attention is given to current trends and developments in the interdisciplinary field of AI in Biomedicine.

Clinical applications project (CAP) in Cardiology/Neurology/Oncology: This course focuses on developing domain-specific expertise in cardiology, neurology, or oncology, and applying informatics to solve practical challenges within these fields. By integrating informatics with clinical applications, the course prepares students for interdisciplinary collaboration in professional healthcare and research environments.

The participants work on advanced clinical application projects in the area of the chosen focus subject under realistic conditions, often in collaboration with clinical or industrial partners. They apply informatics methods to domain-specific problems (design, implementation, validation) within a defined scope and timeline.

The CAP provides opportunities to collaborate with university hospitals, industry partners, and international research institutions. This not only accelerates the development of independent research skills but also fosters an environment in which student-initiated innovations can lead to early publications and serve as a springboard for future academic and professional endeavors.

The AIBM office will assist in arranging placements at our national and international partner universities, research institutes, and industry partners. The results of the project work are documented in writing and presented orally (interim presentations) and discussed in the group.

Accordingly, the module also focuses on fostering communication skills – particularly constructive dialogue that embraces diverse perspectives within a group – as well as cultivating the ability to critically reflect on one's own actions, especially with regard to their societal and ethical dimensions.

Master's seminar: In the Master's Seminar, students independently explore a challenging academic topic in the area of their focus subject, using literature they have researched themselves. Based on this, they write a seminar paper (approximately ten pages in length) and present and discuss their findings within the seminar group. Their arguments are expected to be both theoretically and methodologically sound. Through this process, students also develop their communication and collaboration skills. In particular, they learn to engage in academic discourse while considering the diverse perspectives and interests of other seminar participants.

TUM and FAU offer a wide range of seminars, allowing students to choose from a broad spectrum of topics. The dates for the in-person sessions are arranged individually with the participants. Typically, each seminar is limited to 10 to 20 students.

Master's thesis

As part of the six-month Master's Thesis, students are required to independently address a specific and complex research question within the field of AI in Biomedicine, applying the specialized knowledge and methodological skills acquired during their studies. A key challenge lies in identifying the essential aspects of the broader context necessary to solve the problem within these domains.

In the written thesis, students must explain their chosen approach and demonstrate their ability to present it in a technically sound and academically rigorous manner. They are expected to situate their work within a broader scientific context and also reflect on social implications of their research. The thesis also includes a presentation of the results (20 to 30 minutes), which is not graded. This presentation allows students to show that they can communicate their scientific findings clearly and critically to an audience of subject-matter experts.

The Master's Thesis can be supervised by one of the preferably participating chairs within TUM or FAU, reflecting the interdisciplinary nature of the program. Collaboration with external research institutions or industry partners, both domestic and international, is also possible and highly encouraged.

Research Excellence Certificate (Prädikat „with Honours“)

Very talented and ambitious students can earn at least 30 CP in addition to the curriculum to graduate with the research excellence certificate (Prädikat "with Honours"). For this, the students will select an additional skills course from the cross-cutting themes area, as well as a second focus subject with one additional elective curse, one additional seminar and an additional research project. If the original application project has already been completed at TUM or FAU, the additional one should preferably be completed either with one of the industrial or academic partners.

Semester	Research Excellence Zertificate		Credits/ number of exams
1.	**Focus** (elective) 6 CP		35/7
2.	**Master Seminar** (elective) 5 CP	**Skill course** (elective) 4 ECTS	30/8
3. Mobility window	**Research Project** (mandatory) Projectwork international or academic partners 15 CP		30/6
4.			30/1

Table 6: Sample degree chart for the Research Excellence Certificate.

Mobility window

Students enrolled in the AIBM Master's program are encouraged to incorporate international experience into their academic journey. The curriculum is designed to support mobility, particularly during the third semester, which offers a well-structured window for studying abroad without delaying graduation. This is made possible through a flexible selection of elective modules, allowing coursework completed at partner institutions to be credited toward the degree.

In addition to academic coursework, students may complete both the Clinical Application Project and the Master's Internship at their host institution. These components are fully recognized by TUM, supported by a streamlined and generous credit transfer process. Program coordinators provide close guidance throughout the planning phase, assisting students in selecting appropriate courses and preparing for their time abroad.

Students also have the opportunity to take interdisciplinary modules—such as language courses or courses in ethics, law, and philosophy—which can be credited toward the program's cross-cutting section.

Furthermore, the Master's Thesis may be conducted in collaboration with a TUM chair at FAU, another university, a non-university research institution, or an industry partner, either in Germany or abroad.

Student-led activities

Besides lectures, exercises, tutorials and the described "hands-on" projects, we will offer novel, innovative student-faculty interaction in form of "Student-initiated Colloquia" and student organized workshops (supported by the administration logistically and financially). The student initiative will give students broad exposure to current high-profile research and will allow for practicing presentation skills. For these colloquia, every semester all members of AIBM (students and faculty) will suggest and vote for high-profile international researchers to present their latest results and to

spend time with the AIBM students for discussions. Besides training scientific discussions in such sessions, all students will be required to actively host at least one speaker and arrange a personalized visiting program (identifying and scheduling lab tours with matching local groups, arranging personal research discussions in small groups, and – whenever possible – design a social program). Here, students will take on responsibility early in their career, train crucial abilities for a scientific career (that are outside of direct scientific skills) and – last but not least – establish contacts in their respective fields.

Support and supervision

Complementing the formal activities is our dedicated 1:1 mentoring and coaching system, which pairs each student with a dedicated faculty member. This allows the students to discuss electives of their curriculum (learning agreement), get feedback on their progress and also discuss career choices. Furthermore, the students will be mentored in the development of essential professional skills, such as entrepreneurship, innovation management, and science communication.

In addition, the AIBM will also help with basic orientation problems in a new country (for international students) or act as a person of trust in case of conflicts and personal problems related to their studies. If needed, they establish contact with professionals at their institutions.

Peer-to-peer mentoring will be put in place by introducing both ongoing cohorts during the welcome event for new students and at the annual summer school/retreat. We will encourage the senior students via a staff-student assembly (meeting once per semester) to exchange experiences and information, and to facilitate an open and inclusive environment. We will also foster the exchange between the two ongoing cohorts and the alumni by organizing alumni days. This will provide the students with a great insight into future career paths in industry and academia.

7 Organization and Coordination

In terms of organization, the degree program is based at the TUM School of Computation, Information and Technology and in the Professional Profile Data Science and Artificial Intelligence.

In addition, the Friedrich-Alexander-Universität Erlangen-Nürnberg is involved in the degree program.

The following administrative tasks are performed partly by the TUM Center for Study and Teaching (TUM CST) and its administrative units, partly by offices in the schools or departments:

- Student Advising: Student Advising and Information Services (TUM CST)
  Email: studium@tum.de
  Phone: +49 (0)89 289 22245
  Provides information and advising for prospective and current students (via hotline/service desk)
- Departmental Student Advising: Departmental: Dr. Hannah Eichhorn, msaibm.asa@xcit.tum.de
- Academic Programs Office (APR-O): msaibm.asa@xcit.tum.de
- Study Abroad Advising/Internationalization:
  TUM-wide: TUM Global & Alumni Office
  globaloffice@tum.de
  Departmental: CIT DSAI
  Carola Jumpertz, carola.jumpertz@tum.de
- Gender Equality Officer: TUM-wide: Dr. Daniela Schwarz
  daniela.schwarz@tum.de, Tel. +49 (0)89 289 22335
  Talent Management & Diversity
- Advising – Barrier-Free Education: TUM-wide: Service Office for Disabled and Chronically Ill Students (TUM CST),
  Email: Handicap@zv.tum.de
  Phone: +49 (0)89 289 22737
  Departmental: APR-O
  Barrier-Free Education
- Admissions and Enrollment: Admissions and Enrollment (TUM CST)
  Email: studium@tum.de
  Phone: +49 (0)89 289 22245
  Admissions, enrollment, Student Card,

	leaves of absence, student fees payment, withdrawal
• Aptitude Assessment (EV):	TUM-wide: Admissions and Enrollment (TUM CST) Departmental: Dr. Hannah Eichhorn, app-msaibm.asa@xcit.tum.de
• Semester Fees and Scholarships:	Fees and Scholarships (TUM CST), Email: beitragsmanagement@zv.tum.de
• Examination Office:	Graduation Office and Academic Records (TUM CST) Campus Munich/Garching/Weihenstephan/ Klinikum rechts der Isar Graduation documents, notifications of examination results, preliminary degree certificates
• Departmental Examination Office:	Dr. Hannah Eichhorn, msaibm.asa@xcit.tum.de
• Examination Board:	Prof. Daniel Rückert Email: office@aim.cit.tum.de
• Quality Management:	TUM-wide: Quality Management (TUM CST), https://www.tum.de/studium/tumcst/teams-cst/ Departmental: TUM SoCIT, PP Data Science and Artificial Intelligence (DSAI), Dr. Monica Serbu Email: monica.serbu@tum.de Academic Program Director, PP DSAI QM-SoCIT: Dr. Thomas Stolte Email: stolte@tum.de

8 Enhancement Measures

The inaugural cohort of the AIBM Master's program is scheduled to commence in the winter semester of 2026–2027. As such, enhancement measures have not yet been implemented. However, a comprehensive, multi-tiered quality assurance framework has been established. This framework not only integrates the existing quality management protocols of TUM, but also introduces an active role for the AIBM Steering Committee. In close collaboration with the participating school and future AIBM students, the committee will contribute to the continuous development and refinement of the program, ensuring its academic excellence and responsiveness to emerging needs.

AIBM will comply with the TUM Quality Management approach (TUM successfully renewed its system-accreditation in 2020 by AAQ). This is followed by continuous monitoring with the aim of further developing the study program based on feedback information (3 levels); (1) includes continuous lecture evaluation by feedback questionnaires, (2) regular program evaluation, including a regular online survey and focus groups comprised of current and former students, (3) the peer-review will include the strategic external view of the external advisory board and external program reviews by ENB provide cross-departmental evaluation (L3). FAU is also system-accredited and has similar instruments and will monitor the FAU-led courses.

All activities of AIBM will be continuously monitored and evaluated by the AIBM Steering Committee (SC, AIBM speaker, two vice speakers, for relevant topics also two elected student representatives) in close intervals: We will use the existing online survey tools for evaluation of the lectures and seminars, as well as develop our own questionnaires to get program wide feedback from the current and former students and faculty of AIBM.

Courses/Teaching/Didactics/Projects: Questionnaires will be reviewed by the SC, if required they will seek a discussion with the involved school/collaboration partner. Students also have the opportunity to speak to their mentor and their student representatives (direct link to the SC) or address their needs in the general assembly. Training by TUM ProLehre and FAU will be offered to the school.

Curriculum: The curriculum will be continuously adapted and revised, taking into account feedback from school, students, alumni and the external advisory board.

Selection process: The selection process will be evaluated each year and adjusted if needed. The goal is to have a well-balanced group of talented students.