MEDICAL INFORMATICS INITIATIVE GERMANY

Junior Research Groups

Networking Coordination MII- Junior Research Groups
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March 2026

Junior Research Groups of the Medical Informatics Initiative (MII): Insight into their Projects

With funding from the:

Federal Ministry of Research, Technology and Space

Funded by the Federal Ministry of Research, Technology and Space

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January, 16th 2026

Foreword

The promotion of young scientists is a key factor for the sustainable advancement of science and research. In the field of medical informatics, the promotion of young talent is particularly important for the development of innovative solutions to the challenges of modern healthcare.

Since September 2023, the networking activites of all junior research groups have been coordinated from the Dresden site to enhance their visibility and scientific impact within and beyond the MII. National and international networking plays a central role in this effort, as well as the integration of junior researchers into the organisational structures of the Medical-Informatic-Initiative (MII).

This initiative not only provides opportunities for early-stage researchers to support and learn from each other, but also opens doors to lasting collaborations that extend beyond the initiative itself. Strengthening visibility and integration into larger scientific networks aims to accelerate the translation of innovative research into practice and to drive the development of cutting-edge technologies in healthcare.
We cordially invite all interested parties to gain an insight into the work of the early-stage research groups and wish all participants every success in advancing these pioneering projects.

Yours sincerely,

Brita Sedlmayr and Anne Seim
Network Coordination MII-Junior Research Groups

Brita Sedlmayr

Anne Seim

MEDICAL INFORMATICS INITIATIVE GERMANY

Junior Research Groups

Since September 2023, the Networking Coordination, located in Dresden, has been coordinating the networking activities of all junior research groups with a focus on fostering connections among them, integrating them into the operational structures of the Medical Informatics Initiative (MII), and enhancing their visibility both within and beyond the MII.

The overarching goal of the planned project is to promote the exchange and networking of the junior research groups within the MII, both at the leadership level and among the team members of the junior research groups.

Additionally, the project aims to integrate the junior research groups more effectively into the operational structures and committees of the MII.

The sub-goals defined for achieving successful networking of the junior research groups within the MII include:

- **Increasing the exchange of information among the junior research groups (leadership, team members)**
- **Enhancing the exchange of information between the junior research groups and the operational structures/committees of the MII, along with ensuring the active participation of the junior research groups (National Steering Committee/Main Committee, MII-working groups, module-2-projects)**
- **Enhancing the visibility of the junior research groups within and beyond the MII identity**

We would be pleased to put you in contact with our junior research groups.

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Junior Research Groups in the Medical Informatics Initiative

The Medical Informatics Initiative (MII), funded by the Federal Ministry of Research, Technology and Space coordinates 21 Junior Research Groups operating at the intersection of computer science and medicine. With a budget of approximately 30 million euros (2020–2027), these groups contribute to the establishment of new medical informatics professorships. They leverage innovative technologies such as artificial intelligence and machine learning to sustainably enhance healthcare delivery and research.

The Junior Research Groups are affiliated with the following four consortia of the Medical Informatics Initiative and pursue a wide range of research objectives:
from developing methods and systems to investigating demand-driven solutions and advancing imaging analytics.

Figure: The MII- Junior Research Groups in Germany

Title: AI-assisted morphomolecular Precision Medicine in Neuro-oncology

Consortium: MIRACUM

Head: Dr. Daniel Amsel

Brain tumors are not only associated with high socio-economic costs but also with significant psychosocial burdens, as they affect the brain, the organ of consciousness and perception. They are among the deadliest types of cancer, for which there are currently few treatment options, and they are the second most common cancer in children.
In recent years, treatment has become increasingly individualized through the use of molecular markers with prognostic or predictive significance.
The junior research group "AI-RON" aims to usher in the next era of morphomolecular diagnostics by developing AI-based medical informatics pipelines to improve the quality and speed of brain tumor diagnosis and to personalize and enhance therapeutic approaches. The group's goal is to develop an AI-based precision analysis of digitized histopathological tissue slides in combination with high-dimensional omics data and clinical metadata for the classification and prognostic prediction of brain tumors within the framework of the Medical Informatics Initiative.
Within the Gießen Use Case 2 "Neuro-oncology" of the MIRACUM consortium, access to a large data pool from participating sites allows for the cross-site evaluation of aggregated morphomolecular and clinical data. The developed algorithms can be expanded to integrate other high-dimensional data such as radiomics and other types of tumors. The junior research group will make a significant contribution to strengthening the Medical Informatics Initiative in the important field of AI in healthcare research and delivery by advancing AI-supported diagnostic methods in routine pathological work.

BENEFIT

Title: Optimising the benefits and increasing the availability of health data

Consortium: SMITH

Head: Dr. med. Philipp Breitfeld

The goal of the BENEFIT project is to develop concepts and methods that support the future use of this data in research and healthcare. To achieve this, the project, in collaboration with the Medical Informatics Initiative, is already considering which future users will perform which tasks with the data. The focus is on understanding the future users and participating consortia, their operational constraints, including non-negotiable usage conditions, and their substantive goals. This leads to questions and necessary analyses regarding the required data. What data needs to be available, and at what quality? Do these data need to be supplemented by third parties? Through these evaluations, data that are particularly valuable in this context can be identified and prioritized for integration.
In addition to the legal, ethical, and data protection challenges to be considered, the project also examines the actual data owners, not just the legal owners in a juridical sense. Here, factors such as benefits, exploitation/IP rights, ownership relations, and feelings of ownership play a crucial role, which has been insufficiently explored so far. The project will also give special attention to the specific needs of pharmaceutical and medical technology companies, as well as innovative startups, whose working hypotheses may sometimes face resistance from the established scientific community. From this work, fundamental business models can be derived, which, together with other intermediate products such as use cases or success stories, aim to convince data owners on the university side of the advantages of providing data.

DE.xt

Title: Clinical text analytics: Methods for NLP on German Texts

Consortium: DIFUTURE

Head: Luise Modersohn / Dr. med. Jacqueline Lammert

Natural language processing (NLP) is an important capability for extracting and processing information from clinical systems and patient health records. The junior research group DE.xt directly addresses the unmet demand for effective NLP methods and resources adapted for non-English languages in the clinical context in Germany.
Based on nationally and internationally recognized research projects, the group will address core scientific obstacles and their technological realization. The adoption of established international standards and evaluation criteria will ensure methodological precision. By integrating its research into the Medical Informatics Initiative and the DIFUTURE consortium, DE.xt accelerates the implementation of technological progress across healthcare institutions.
NLP is crucial for the development of advanced clinical information systems by enabling the automated retrieval and organization of medical information. This functionality improves the availability and portability of unstructured clinical text, supporting applications such as predictive modeling, phenotyping, and clinical decision support systems (CDSS). The incorporation of ML-based NLP models in these systems allows for sophisticated analyses, and individualized treatment strategies, leading to improved diagnostic precision and patient outcomes.
To overcome domain-specific obstacles and enhance NLP utilization in clinical environments, DE.xt is collaborating with Averbis GmbH, a leader in medical text analytics. The Averbis Health Discovery Platform, currently in use by multiple consortia within the Medical Informatics Initiative, provides a validated framework for NLP-driven information retrieval and knowledge discovery. Furthermore, the Averbis Marketplace offers an accessible distribution channel for NLP tools and resources, enabling their integration into healthcare IT systems.
The Technical University of Munich (TUM), with its established network of leading industrial partners, provides a solid framework for the sustainable translation of scientific findings into commercial applications. This ecosystem promotes the creation of scalable, clinically validated NLP solutions compliant with industry standards and regulatory requirements, ensuring their long-term utility in real-world healthcare settings.

Title: Development of clinically-oriented decision support for high-performance data in personalised medicine

Consortium: MIRACUM

Head: Dr. Geoffroy Andrieux

Precision medicine is increasingly becoming a reality and is steadily being integrated into clinical practice. Unique patient characteristics are being identified to enhance the efficacy and accuracy of treatments. Ambitious initiatives such as the Medical Informatics Initiative (MII) actively support biomedical research in Germany to advance individualized patient care. These efforts heavily rely on the ever-growing volume of health-related data and rapidly evolving technologies.

However, due to the lack of advanced analytical methods, as well as standardization and harmonization processes, only a fraction of the available data is utilized for clinical recommendations. Therefore, the goal is to process and present these complex data in a comprehensible form by developing innovative methods, such as machine learning algorithms (artificial intelligence), and analytical processes. At the same time, these data will be prepared for efficient and practical exchange.

Additionally, efficient IT infrastructures and the development of novel visualization standards are being established to ensure the implementation and application of these methods in clinical settings. This endeavor not only advances the processes of personalized medicine within local clinical environments but also drives the MII and MIRACUM initiatives at various sites.

FAIRRMeDIC

Title: FAIRe and Reliable analysis structures in Medical Data Integration Centres

Consortium: HiGHmed

Head: PD Dr. Dorothea Kesztyüs

A medical data integration centre (MeDIC) handles and processes highly complex multidimensional data. The complexity and also the volume of data continue to increase with new examination and treatment methods of personalized, e.g. molecular medicine. As a result, methodological and technological concepts must be adapted and further developed. This forms the research focus of the FAIRRMeDIC junior research group, which adheres strictly to the FAIR principles - Findable, Accessible, Interoperable, Reusable - and extends them to include the concept of Reliable. To ensure reliable data and enable corresponding data analyses, it is essential to validate the data. This involves assessing and scientifically evaluating data quality. Additionally, data must be protected against unintended alterations, and any change must remain traceable. To achieve this, methods, principles, and systems used in clinical research for drug approval will be applied.
The UMG-MeDIC exclusively works with pseudonymized data, and the extraction and reuse of data are fundamentally regulated. However, how individuals might be re-identified when sufficient medical data are integrated and analyzed has not yet been comprehensively studied. This issue will also be examined as part of the research project. Blockchain methods for securing clinical care data are currently not widely utilized. Some studies have emerged from the fields of clinical trials or clinical pharmacology, but the application of these methods and processes in a MeDIC setting has not yet been explored or implemented.
Finally, the project aims to develop a system for analysis that is capable of handling the multidimensionality and scale of the data, meeting the demands of both complexity and volume.

HiGHDiBi

Title: Spatially resolved highly multiplexed analysis of tissues at single cell resolution

Consortium: HiGHmed

Head: Dr. Denis Schapiro

Highly multiplexed imaging and spatial omics technologies have the potential to revolutionize general pathology by deeply profiling cell states while preserving the three-dimensional architecture of tissues. This provides a unique opportunity for machine learning in the context of precision medicine, since millions of routine clinical samples have been archived and many are linked to retrospective clinical information with untapped potential. While the experimental technologies are rapidly advancing, data analysis and experimental design strategies remain a major challenge for the imaging and spatial omics community. Substantial conceptual and technical breakthroughs will therefore be required to unlock the full potential of high dimensional tissue analysis. At the same time, it is already clear that these novel spatial methods will provide unique capabilities for applying machine learning to clinical data on diagnosis, prognosis, disease progression and toxicity risk information enabling novel discoveries to be integrated directly into patient care.
In pursuit of these opportunities, we aim to develop computer-aided and experimental methods that provide detailed molecular insights into tissue samples in both healthy and diseased states. The resulting cellular profiles, combined with innovative functional assays, aim to enhance our understanding, diagnosis, and treatment of various tissue-based diseases, such as cancer.

IMPETUS

Title: Integrating Multimedia-Objects and PACS Environments into Universal Knowledge Management Systems

Consortium: HiGHmed

Head: Prof. Dr. Björn Schreiweis | Dr. Hannes Ulrich

The IMPETUS junior research group focuses on medical device data and its integration into a Medical Data Integration Centre. The project involves incorporating imaging and other multimedia data into the Medical Data Integration Centre of the University Medical Center Schleswig-Holstein (UKSH), encompassing both DICOM and non-DICOM formats. Imaging techniques play a pivotal role in modern medicine, supporting both clinical care and research. However, only data from specific modalities (e.g., MRT, CT) or clinical departments (e.g., radiology, cardiology) are stored in central DICOM-PACS (Digital Imaging and Communications in Medicine, Picture Archiving and Communication System). The majority of medical imaging data is either not stored in IT systems at all or remains confined to departmental and specialized systems, typically in non-DICOM formats. Additional multimedia objects, such as waveform data (e.g., ECG), audio files (e.g., ENT), and multimedia reports containing both images and text, further complicate the integration process. The goal of this project is to extend the MeDIC established at UKSH under the HiGHmed project to enable the integration and utilization of all multimedia objects and reports, regardless of their format. The following challenges will be addressed: 1) Data Volume Management: Combining referencing approaches with copying strategies to reduce data volume; 2) System and Device Integration: Connecting specialized IT systems and individual medical devices; 3) Metadata Handling for Non-DICOM Objects: Capturing and storing descriptive metadata (e.g., via sidecar files); 4) Tagging for DICOM and Non-DICOM Objects: Implementing additional tagging (e.g., by report types or specific image features); 5) Study Context Management: Enabling multimedia datasets to be stored and bundled within research study contexts; 6) Advanced Search Capabilities: Incorporating pattern-recognition methods for content-based image retrieval; 7) Multimodal Viewing Solutions: Developing solutions for combined visualization of DICOM and non-DICOM objects; 8) Interoperability Standards: Resolving as many elements and process steps as possible using international interoperability standards. This approach aims to ensure seamless integration and use of diverse multimedia objects, enhancing the value and functionality of the MeDIC for clinical and research applications.

iXplain_CDS

Title: Interoperable and eXplainable Clinical Decision Support

Consortium: HiGHmed

Head: Dr. Dominik Wolff

Digitalisation in medicine has led to an increasing availability of clinical routine data, which - if properly integrated, represented, and analyzed - can generate value beyond the original purpose of documentation. One of the major challenges in medical informatics is designing and evaluating systems capable of effectively and reliably utilizing such heterogeneous and high-dimensional data to benefit patients. This includes providing automated support for complex decision-making, a fundamental aspect of medicine.
The quality of medical decisions is significantly influenced by the breadth of explicit and implicit knowledge possessed by healthcare professionals, which is often highly individualized. Additional factors affecting decision-making include high workloads and stress-intensive environments, such as those in intensive care units.
Clinical decision support systems can assist medical professionals with specific decision-making tasks, such as diagnosis or therapy planning, by processing large volumes of clinical (and non-clinical, e.g., patient-generated) data in a very short time. The explainability and interpretability of the recommendations generated by these systems, including transparency regarding the underlying algorithmic logic, are absolutely essential for building trust and ensuring acceptance of decision support.
The iXplain_CDS junior research group focuses on the research and development of clinical decision support systems designed with interoperability to enable deployment across different healthcare institutions. Additionally, by incorporating explanation components, these systems aim to enhance the robustness of predictions and foster trust among both healthcare professionals and patients. The junior research group iXplain_CDS designs, implements, and evaluates clinical decision support systems for a variety of medical use cases.
The focus is on the patients ’well-being, the comprehensibility of the decisions and the systems’ reusability. Knowledge on innovative diagnostic and therapeutic procedures will be made more widely available and will also be made accessible to other healthcare institutions.

Title: Predictive analysis and data-driven artificial intelligence for the logistical support of supply processes

Consortium: SMITH

Head: Dr. Sasanka Potluri

Our research group leverages the potential of artificial intelligence (AI) to develop innovative solutions for the logistical challenges faced by hospitals and healthcare systems daily. From optimizing supply chains and managing patient flow to predicting the maintenance needs of medical devices, our interdisciplinary approach aims to enhance efficiency, reduce costs, and ultimately improve the quality of patient care.

Goal 1 – Optimize Workforce Planning and Scheduling
Employ techniques such as Mixed Integer Linear Programming (MILP), combinatorial optimization, and AI to develop efficient workforce planning systems that align staff availability, demand, and fairness with hospital requirements.

Goal 2 – Enhance Supply Chain Management for Medical Resources
Utilize AI techniques in combination with simulation models to improve inventory management and forecast medical product needs (e.g., blood products).

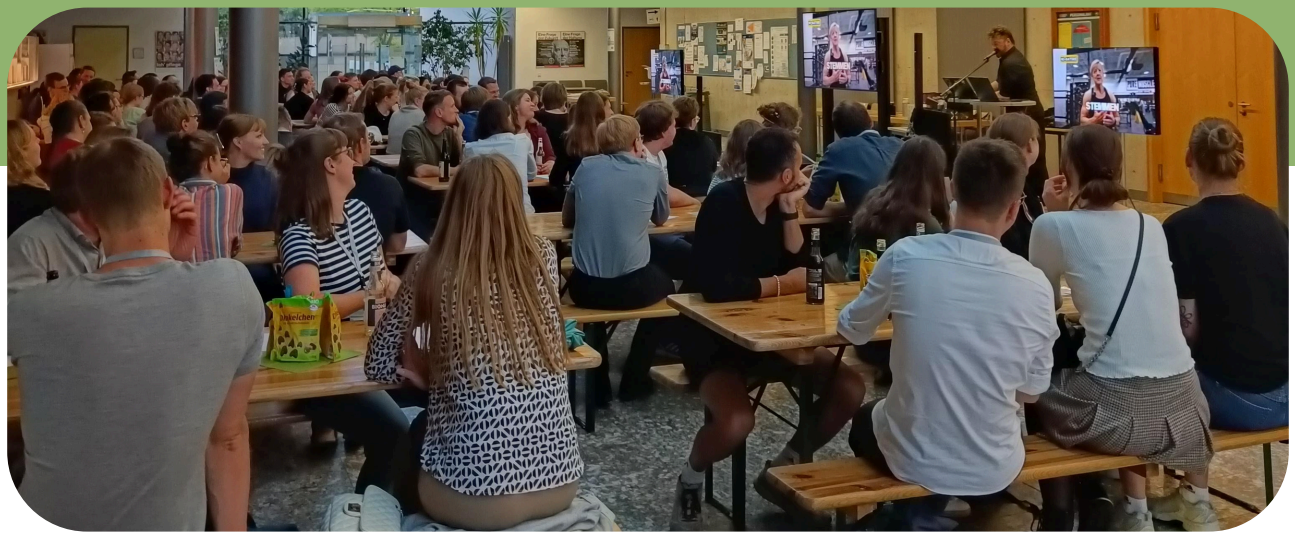
Goal 3 – Intelligent Route Planning and Optimization for Efficient Transport and Deliveries in Hospitals.Develop AI-based solutions for real-time planning, task assignment, route optimization, and transport operations (e.g., patient transport) within hospitals.

Impressions of Networking Activities

Kick-Off-Meeting in Dresden, November 2023

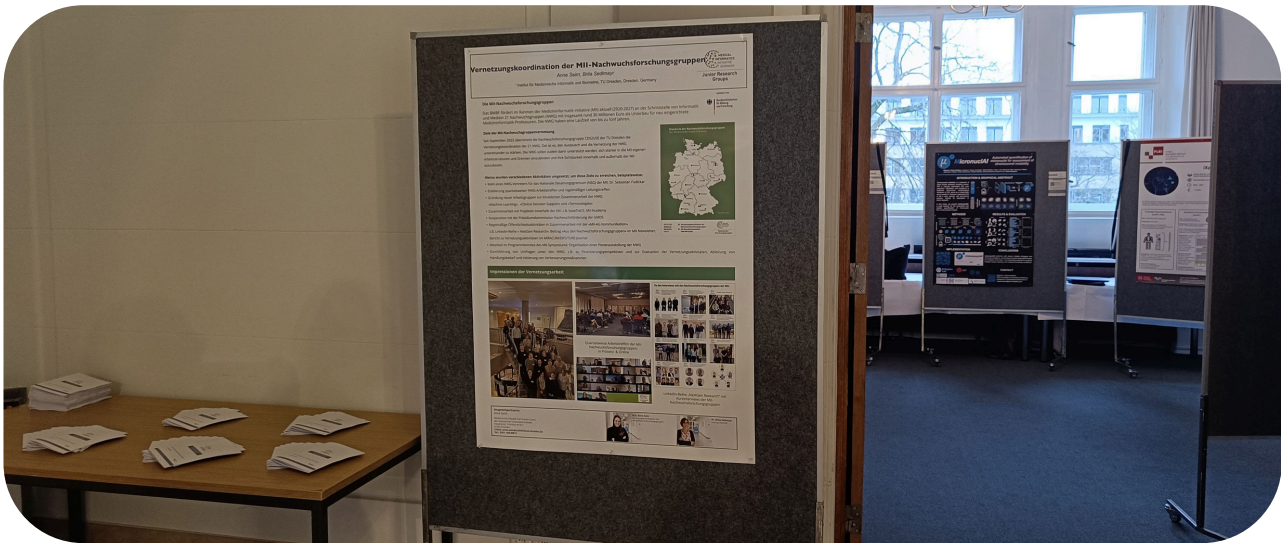
Working meeting in Berlin, December 2024

Impressions of Networking Activities



Young Scientist Night of the GMDS in Dresden, September 2024

Poster exhibition of the Junior Research Groups at the MII Symposium in Berlin, December 2024



Poster exhibition of the Junior Research Groups at the MII Symposium in Berlin, December 2024

MDPPML

Title: Medical Data Privacy and Privacy-preserving Machine Learning

Consortium: DIFUTURE

Head: Dr. Mete Akgün

The exponential growth of medical data has unlocked unprecedented opportunities to revolutionize biomedical research and launch in the era of P4 medicine—Predictive, Preventive, Personalized, and Participatory. By leveraging cutting-edge AI technologies like deep learning, we can transform patient care and medical outcomes. However, realizing this potential requires the efficient and secure sharing of vast clinical and research data among a multitude of stakeholders, which presents significant privacy and security challenges due to the sensitive nature of medical information.

Our research group is dedicated to overcoming these challenges by pioneering innovative, privacy-preserving technologies that enable secure, scalable, and ethical sharing and analysis of clinical and genomic data. We focus on advancing security, privacy, and artificial intelligence within the medical context to facilitate collaboration across networks of medical institutions, hospitals, and research laboratories. By addressing critical issues of scalability, privacy, security, and ethics, we strive to strike an optimal balance between usability and data protection, accelerating the adoption of P4 medicine and unlocking its full potential for improved patient outcomes and biomedical advancements.

MeDaX

Title: Development and implementation of innovative methods and tools for biomedical data exploration

Consortium: MIRACUM

Head: Dr. Judith Wodke

The MeDaX junior research group is developing innovative methods and tools for biomedical data exploration within the medical informatics framework at the University Medicine Greifswald. To extract the necessary knowledge from the available data, it is essential to link and harmonize heterogeneous datasets. Currently, we are implementing a modular method for the automated generation of graph databases from clinical research data, enriched with ontological and other semantic information. As part of the MII, we actively contribute to data management and infrastructure projects aimed at continuously optimizing FAIR health and care research.

MicrobiomSepsisPrep

Title: Prediction of sepsis on the basis of microbiome sequence data

Consortium: SMITH

Head: Dr. Ivana Kraiselburd

The MicrobiomeSepsisPred research group investigates methods for processing, analyzing, and integrating microbiome data from patients in intensive care.
These data are derived from DNA sequencing of blood, gut, and skin microbiota.
They hold predictive potential for the onset of sepsis and the identification of potential antibiotic resistances that could complicate sepsis treatment. For individual patients, a personalized microbiome profile is generated based on sequencing data and utilized in a model for early sepsis prediction. Such a model can complement existing sepsis prediction approaches based on clinical data and offers the potential to accelerate sepsis prognosis.
In addition, the group aims to establish tools for identifying antibiotic resistance profiles within patient microbiomes. This initiative seeks to enhance established methods for predicting the evolution of pathogens and their potential antibiotic resistances, thereby extending the predictive horizon for improved patient outcomes.

Title: Medical Informatics for Holistic Disease Models in personalized and preventive medicine (MIDorAi)

Consortium: MIRACUM

Head: Dr. Maté Maros

The promises of AI - and big data-driven personalised precision medicine have increasingly come under scrutiny, despite AI systems regularly matching or even surpassing the performance of medical expert panels.
The quality of input data for algorithms, particularly structural biases and inequalities in medical datasets (e.g., underrepresentation of certain populations based on gender or ethnic diversity), heightens the vulnerability of AI algorithms. This shift underscores the transition from traditional model-centric AI development to data-centric AI, as the quality of source data determines the fairness, applicability, and limitations of AI algorithms.
In clinical settings, vast amounts of data already exist, though they are often unstructured and highly heterogeneous. The focus of the MIDorAI research group lies in the structured annotation and enrichment of radiological report texts (leveraging ontologies like RadLex®) and their holistic integration with imaging, multimodal laboratory, and high-throughput data.
Another critical aspect of medical data gaining prominence is ensuring data privacy for highly sensitive patient information. The multimodal disease models developed by MIDorAI, along with the generation of synthetic data derived from them, are set to play a pivotal role in addressing these privacy challenges.
As part of the research group's objectives, we aim to develop data integration and modeling tools as a comprehensive platform. These tools will be made available within the Medical Informatics Initiative (MII), to the broader research community, and as a Software as a Service (SaaS) solution.

MoMoTuBo

Title: Modular Knowledge and Data-Driven Molecular Tumour Conference

Consortium: DIFUTURE

Central contact: Sebastian Lutz

MoMoTuBo focuses on the development of concepts and prototypes for a modular software platform to support the processes of a MTB. The innovative aspect lies in the modular structure designed for various subprocesses within the overall workflow and its emphasis on implementing reproducibility, documentation, and update mechanisms throughout the process.
Key aspects of this junior research group include conceptual development, infrastructure setup, data preparation and analysis, integration of prior knowledge, and embedding the platform into clinical practice. A strong emphasis is placed on promoting reproducible research, with the overarching goal of equipping disciplines to achieve a level of scientific methods and research software professionalism that allows seamless integration into clinical routines.
The group's scientific and technical objectives include:

- The conceptualization of a modular MTB design that ensures reproducibility, documentation, and update mechanisms are implemented throughout the process.
- A concept for integrating with clinical routine systems and research data systems.
- An improvement and (partial) automation of data integration and comprehensive processing with the incorporation of external knowledge.
- The development of machine learning methods for:
  - Learning from similar cases ("patients like me").
  - Utilizing unstructured knowledge (e.g., medical reports, scientific publications).
  - Identifying complex signatures, potentially across multiple data layers, to predict therapy response or resistance.
  - Implementing continuous learning in clinical applications.
- The creation of a prototype and open-source software for a modular platform to support a molecular tumour board.

MoveGroup

Title: Integration and analysis of multimodal sensor signals for research on neurological movement disorders

Consortium: HiGHmed

Head: PD Dr. Sebastian Fudickar

The junior research group designs, implements, and evaluates novel methods for integrating and analyzing multimodal sensor signals and clinical data to diagnose and investigate movement disorders. The scientific objectives and research efforts of the project are structured around the following three primary goals:

Goal 1 – Sensor-Based Capture and Modeling of Body Movements:
Through the development of a multimodal sensor platform for the detailed recording of body movements and the creation of an algorithmic processing pipeline for sensor data fusion and feature extraction, precise quantitative analysis of body movements will be enabled.

Goal 2 – HiGHmed-Compliant Data Integration and Utilization:
To integrate and utilize relevant sensor-based movement models and profiles for healthcare and research processes, concepts for data storage in a data warehouse will be developed and evaluated, ensuring compliance with data protection regulations and ethical implications.

Goal 3 – Decision Support and Knowledge Discovery Using AI Methods:
To create AI-based decision support systems for the medical care of patients with movement disorders, machine learning models will be developed using the collected multimodal movement data.

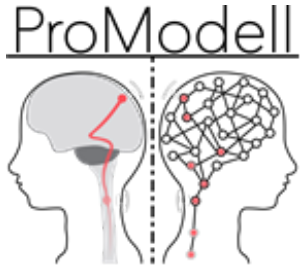
Title: Analysing mobile data to monitor the development of neurodegenerative diseases

Consortium: SMITH

Head: Dr. Lara Marie Reimer

Neurodegenerative diseases (NDDs) pose an increasing burden on society. Globally, millions of people suffer from NDDs, with Alzheimer's disease and Parkinson's disease being the most prevalent. Those affected experience a wide range of impairments, particularly in cognition and motor function. Early intervention is crucial, as the loss of neuronal functions is often irreversible, even with pharmacological treatment. However, NDDs are typically difficult to detect in their early stages, and diagnostics are often complex and expensive. Research has demonstrated that more cost-effective technological approaches, such as gait analysis, can facilitate early detection of NDDs. The junior research group NDEMobil investigates technological solutions for the early diagnosis and monitoring of NDDs. The group focuses on the use of mobile devices such as smartphones and wearables, which offer diverse applications due to their widespread availability. These devices aim to collect various parameters during everyday use that can provide insights into motor function, cognition, and social behavior. Data collection is designed to be secure and privacy-preserving. The goal is to detect changes in usage patterns that may indicate the onset or progression of an NDD.
To achieve this, the research group identifies potential parameters and develops various testing methods to capture these parameters via a mobile app. The app will subsequently be deployed in an observational study to collect data from patients with NDDs at different stages. Based on the findings, suitable digital biomarkers will be selected and tested in an interventional study.

ProModell



Title: Interactive generation and simulation of prognostic, personalised digital patient models

Consortium: MIRACUM

Head: Prof. Dr. Andreas Rowald

The junior research group ProModell sets new standards in the development of virtual prototypes and clinical decision support systems for high-precision interventions in the nervous system. Aiming to transform biomedical interventions from "trial-and-error" approaches to precisely planned, personalized technologies, *ProModell* lays the foundation for groundbreaking advances in symptom relief, functional support, and the restoration of physical abilities.
By utilizing state-of-the-art technologies, such as innovative computer vision methods, ProModell automatically generates highly accurate, three-dimensional models of the nervous system and adjacent structures. These models are based on multimodal imaging data and set new benchmarks in multi-scale and anatomical precision.
With pioneering approaches from computational physics, computational neuroscience, and artificial intelligence, these digital twins enable realistic simulations of the physiological effects of biomedical devices on or within the nervous system. This approach paves the way for safer, more efficient, and tailored therapies for treating neurological diseases.

SAFICU

Title: Implementation of Smart Contract Technologies for Analysis Federation in Intensive Care Medicine

Consortium: DIFUTURE

Head: Dr. Mathias Kaspar

The junior research group focuses on the intersection of machine learning and statistics in combination with the use of distributed datasets. The emphasis is on the development, application, and evaluation of innovative methods that enable comprehensive analysis of distributed datasets without requiring sensitive and detailed data to leave the respective institutions. This approach addresses key challenges in data privacy and security, particularly in medical research involving critically ill patients.
A primary goal of the group is the expansion and standardization of intensive care data documentation. The MII core dataset will be provided to facilitate a uniform and efficient use of data. Based on this foundation, algorithms for specific medical use cases are being developed and validated. Two key application areas are the focus: blood transfusion management for intensive care patients and optimization of ventilation strategies. Both scenarios present complex challenges, and overcoming them through data-driven approaches and machine learning offers significant potential for improving clinical practice.
The methods development is based on the internationally recognized data model OMOP CDM (Observational Medical Outcomes Partnership Common Data Model), which has already proven successful in the DIFUTURE initiative. This data format enables standardized representation and integration of medical data, ensuring interoperability between different institutions and studies. Additionally, the research group is dedicated to exploring and applying especially secure cryptographic techniques, particularly in the field of Secure Multiparty Computation (SMPC).

TOP

Title: Terminology and ontology-based phenotyping

Consortium: SMITH

Head: Dr. Alexandr Uciteli

We focus mainly on algorithmic phenotyping, that is the software-supported identification of individuals or cohorts with certain characteristics (phenotypes). Having analysed the notion of a phenotype in an ontological fashion, we developed a technique for modelling phenotypic knowledge on this basis. The phenotype models developed in this manner are structured, explainable and executable. This means that queries can be defined on their basis and executed on various data sources. Established medical terminologies such as LOINC or SNOMED play an important role in identifying relevant data in the data source. Phenotypic models can be used, for example, to recognise certain diseases, to assess risk, to avoid adverse events or to identify study participants.
Another aspect of our research is the semantic search in text documents (for example clinical reports). Here we develop NLP methods (such as for document clustering or terminology extraction) that support an ontology-based search.
We implement both components, i.e., the phenotyping on structured data and the semantic search in text documents, in our so-called TOP Framework. Using this framework, phenotype models and Search Ontologies (classification of concepts of a text search query) can be developed by experts without IT knowledge and executed on the desired data sources. The results are data sets that fulfil all the criteria of the query – in the first case, persons who exhibit the defined phenotypes, and in the second case, text documents that contain or are represented by the concepts.

MIRACUM-DIFUTURE SYMPOSIUM 2024

Guestarticle by Celine Brandelik and Maximilian Karg

The MIRACUM-DIFUTURE Symposium 2024, which took place on October 10 and 11 in Munich, provided an ideal platform for the exchange and discussion of current topics in medical informatics. One of the highlights of the event was the first presentation of the Young Research Group Award, which went to the IMPETUS team led by Prof. Dr. Björn Schreiweis. The team impressed the jury with its innovative approach to integrating medical multimedia data into universal knowledge management systems. In his speech, Prof. Schreiweis emphasized the growing importance of linking clinical image data for research and clinical care. Through their work, the IMPETUS scientists are helping to further close the gap between research and practice.

In addition to the winning team, the other finalists also impressed with their contributions:

- Christoph Beger (SMITH consortium) presented a novel phenotype repository designed to improve data integration and phenotypic analysis.
- Dr. Ali Burak Ünal (DIFUTURE) presented a privacy-friendly method for age prediction based on DNA methylation data.
- Dr. Judith Wodke and Ilya Mazein presented the development of a FHIR-based knowledge graph for the systematic networking of medical knowledge.

The symposium provided an excellent opportunity to promote dialogue between science, research and clinical practice. The junior research groups presented pioneering projects that have the potential to transform medical care and research in the long term.

MII-SYMPOSIUM 2024

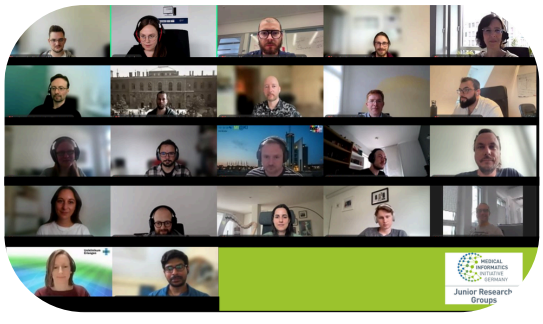
At the MII Symposium in December 2024, the Junior Research Groups played an important role in presenting their research contributions. They focused on strengthening collaboration and promoting scientific exchange within the medical informatics community. A major highlight was the poster exhibition, where the Junior Research Groups had the exclusive opportunity to present their projects and work. This included the winning poster by HiGHDiBi from the HiGHmed consortium by Miguel Ibarra. They received the poster prize for their innovative work on digital image analysis.

In addition to the winning team, the other finalists also impressed with their contributions:

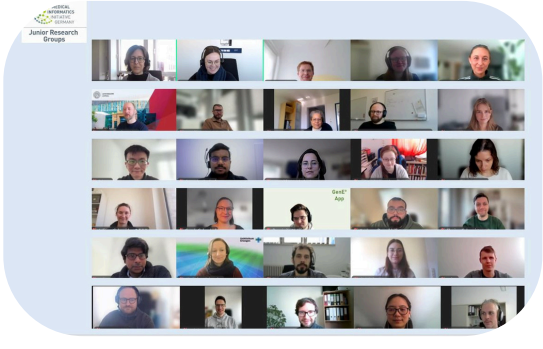
- Ilya Mazein, MeDaX (MIRACUM)
- Florian Schweizer, NDE.Mobil (SMITH)

Working Meetings

A so-called working meeting of the Junior Research Groups takes place quarterly. These meetings offer significant added value by promoting professional exchange and networking. They provide young researchers with the opportunity to present their projects and research focuses, as well as to identify potential collaborations. The meetings strengthen the integration of the Junior Research Groups into the MII work structures, offer keynote lectures on current topics, and facilitate in-depth discussions on challenges and opportunities through breakout sessions.



Virtual Working-Meeting, December 2024



Online-Working-Meeting, March 2025

In-person meeting in Berlin, December 2024

Once a year, an additional in-person meeting takes place, which is particularly valuable for building closer connections. These meetings not only strengthen the networking of young researchers but also promote the development of joint projects and the resolution of current scientific challenges. The combination of virtual and in-person meetings ensures sustainable and effective collaboration.

MEDICAL INFORMATICS INITIATIVE GERMANY

Junior Research Groups

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Funded by the Federal Ministry of Research, Technology and Space

With funding from the:
Federal Ministry of Research, Technology and Space