- **Complete title of the project**
  - MAIHRT - Mathematical AI in Healthcare: Research and Teaching Perspective
- **Principal Investigators: Names and affiliations of both Indian and German PIs**
  - Name of Indian PI: Dr. Subha D. P., Department of Electrical Engineering, National Institute of Technology Calicut, Kerala, India.
  - Name of Indian Co-PI:
    - Dr Satyananda Panda, Department of Mathematics, National Institute of Technology Calicut, Kerala, India.
    - Dr. Jeetu S. Babu, Department of Materials Science and Engineering, National Institute of Technology Calicut, Kerala, India.
  - Name of German PI: Prof. Dr. Thomas Götz, Mathematical Institute, University of Koblenz, Germany.
  - Name of German Co-PI: Prof. Dr. Maik Kschischo, Department of Computer Science, University of Koblenz, Germany.
- **Institutions involved: Names of all collaborating institutions**
  - National Institute of Technology Calicut, Kerala, India.
  - University of Koblenz, Germany.
- **Short Project Summary (few lines): Brief overview of the project's aims, focus areas, or methodology**
  - In the current proposal, we aim to use a combination of machine learning, mathematical modeling, and simulation techniques to address two main challenges currently faced by a vast majority of the population.

  - Alzheimer's disease (AD) is a growing healthcare burden that is affecting the life of more than 50 million individuals worldwide. Electroencephalogram (EEG) signals are widely used by physicians for interpretation and identification of physiological and pathological phenomena. This proposal aims at introducing AI techniques which could be employed for the development of biomarkers for the early prediction of AD using EEG signals. Nanomaterial based targeted drug delivery has emerged as a competent treatment plan for AD as it provides mechanisms to overcome the blood brain barrier, and also minimise the drug dosages. Hence, we also propose to perform machine learning assisted molecular simulations to investigate the suitability of boron nitride nanotubes (BNNTs) as nanocarriers for the delivery of AD drugs to the affected area. This project will also look into developing AI based mathematical models to analyze the impact of temperature, rainfall, humidity, and other climate variables on vector-borne disease transmission patterns. Special attention will be given to Kerala, a state in southwest India where dengue and malaria are endemic, and Germany, where changing climatic conditions may create conducive environments for these diseases.

    An integral component of this initiative is the development of modular, interactive teaching materials, from an interdisciplinary viewpoint, covering foundational and advanced topics in AI-driven modeling and simulation, with case studies derived from the research outcomes.

    Objectives:

    - Modeling, detection, and treatment for AD using AI tools.
    - Modeling and Simulation of Climatic Factors Influencing the Spread of Vector-Borne Diseases.
    - Development of teaching material “Machine Learning techniques to solve differential equations” for the master programs in Calicut and in Koblenz

- **Expected Outcomes: Key goals, impact areas, or potential deliverables**
    - A comprehensive mathematical model that captures dengue transmission under vaccination in an age-structured population.
    - Numerical results, including AI-based simulations, demonstrating the effects of vaccine efficacy, vaccination rates, and host-vector interactions.
    - Simulation-based insights on optimal vaccination strategies, targeted by age and immunity Therefore, it is natural to understand how the disease dynamics are predicted by an age-structured epidemic model with vector transmission under vaccines.
    - Possible public health policy recommendations based on model output, especially relevant for regions with demographics similar to the Kerala dataset.
    - Explore the possibilities of employing deep learning models for early and accurate classification of different stages of AD using temporal and spectral features in EEG.
    - Perform machine learning assisted molecular simulations to investigate the suitability of BNNTs (pristine and modified) as nanocarriers for the delivery of AD drugs to the affected area.
    - Development of modular, interactive teaching materials that align with master-level curricula in mathematics, engineering and computer science.
    - A series of three compact courses (2x at the NITC, September 2025 and January 2026 and 1x in Koblenz, November 2025) and a workshop at the NITC (January 2026), theoretical concepts, practical computer exercises, and application-oriented case studies will be presented. German faculty members will give compact courses on “Mathematical Models and Simulations in Health and Life Sciences”, and “AI for Data Analysis”. The Indian faculty members will give a compact course on “Application of AI in detection and treatment of AD”.
- **High-resolution visuals (optional but welcome): Images or short videos from project activities—such as meetings, lab work, or partner visits—along with captions and photo credits**
    - We have already conducted collaborative online meetings with Prof. Thomas Goetz and Prof. Maik to discuss project plans, modeling, and solution techniques. Prof Thomas will be visiting us towards the end of September 2025.