ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

INRiM - Artificial Intelligence combined with in silico modelling to support disease diagnosis

Funded By	I.N.RI.M. - ISTITUTO NAZIONALE DI RICERCA METROLOGICA [P.iva/CF:09261710017]
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Context of the research activity	The topic of the proposed research activity is the development of methodologies for the assessment of the trustworthiness, reliability and explainability of image-based Artificial Intelligence (AI) tools for disease detection. The AI tools will be tested on clinical data, coming from breast cancer screening with mammography, and in particular from large-scale diagnostic imaging databases, made available by cancer screening centers across Europe.
Objectives	The research will be conducted in the framework of the European Metrology Partnership Project 22HLT05 MAIBAI “Developing a Metrological framework for Assessment of Image-Based Artificial Intelligence systems for disease detection”, coordinated by INRiM and started in September 2023. The first objective is the categorization of the clinical data, i.e. x-ray breast images (mammograms), into subsets based on relevant subgroups within the screened population and image acquisition key-factors, affecting image quality and subsequent cancer detection rates. The data will also be split into separate sets for AI tool training, validation (e.g., for hyperparameter selection), uncertainty calibration and testing. The main source of data will be the OPTIMAM Mammography Image Database, developed by one of the partners of the MAIBAI’s consortium, the Royal Surrey NHS Foundation. The second objective is the implementation of in silico models to generate synthetic mammograms for supplementing incomplete datasets and provide a ground truth for AI tool benchmarking. To mimic mammography procedures, compressed versions of high-resolution breast digital phantoms will be generated, simulating realistic tissue deformation by means of biomechanical modelling. The irradiation process will be numerically replicated following the image acquisition pipeline, to obtain a wide set of clinically realistic images, with variable anatomical properties and pathology features. To extend the datasets for AI tool benchmarking, synthetic mammograms will also be generated via data augmentation techniques based on generative deep learning models.

	The third objective is the assessment of the performance of tailored AI tools, by using both clinical and synthetic mammograms. Benchmarking will be carried out on prediction tasks with high clinical relevance, e.g. breast cancer risk estimation, tissue segmentation, abnormality detection and classification/grading. The performance will be tested under various scenarios, including low versus high image quality data, validation for specific patient demographics, presence of machine-based artefacts and noise sources.

Skills and competencies for the development of the activity	- Competences in data analysis and data preparation, fundamentals of statistics, and skills in machine learning and deep learning models; - Basic knowledge of machine learning frameworks, e.g. PyTorch, TensorFlow; - Basic knowledge of numerical modeling and computer programming, e.g. Python, C++.