Title

Leveraging synthetic data and performance metrics to validate AI models in diagnostic imaging

Objective

The proposed research activity focuses on the assessment of AI models for diagnostic imaging, particularly for disease detection in breast cancer screening, using both synthetic and clinical data.

Description

The proposed research activity aims to develop cutting-edge methodologies for the assessment of the trustworthiness, robustness and reliability of Artificial Intelligence (AI) models in diagnostic imaging applications. These AI models, designed for disease detection tasks, will be tested on clinical data, mainly from mammography breast cancer screening. Additionally, AI-driven generative models will be developed to expand the available datasets by applying data-driven information approaches, such as neural style transfer methods based on generative adversarial networks. Specific attention will be devoted to *domain generalization* and *explainability* tasks, ensuring that AI systems are not only accurate but also interpretable and adaptable to different contexts. Quantitative metrics and visual explanation techniques, like gradient-weighted class activation mapping, will be applied to evaluate the AI model performance and make the decision process more transparent. *Uncertainty quantification* will be also introduced, in order to quantify and understand the inherent uncertainty or variability associated with the AI model predictions.

Part of 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"* (https://www.maibaiproject.eu/), coordinated by INRiM and started in September 2023. The aim of MAIBAI is to develop a standardized and impartial framework for performance, generalizability and suitability assessment of AI models, to enable a more efficient, reliable and reproducible validation of image-based AI systems for disease detection. Using breast screening as an exemplar, AI models are benchmarked on a large real-world database of mammographic images, with the final goal of designing a metrological framework for AI assessment and explainability in diagnostic imaging.

Skills and competencies for the development of the activity

- Data analysis and data preparation, fundamentals of statistics, machine learning and deep learning models;
- Basic knowledge of machine learning frameworks (e.g., PyTorch, TensorFlow);
- Basic knowledge of computer programming (e.g., Python).

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